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EVER notice the ambling, jelly-fish kind of individual slouching along the highway, his chest sunken, his shoulder blades sticking out and his head bowed down? Sure you did! And you had a strong desire to steal up from behind and straighten him up with a drive of your fist? Sure again!

His ailment is loss of backbone; he cannot get anywhere in particular, even to going straight ahead; he does not care; he is invertebrate, spineless.

Let us get off the highway for a minute and approach a little nearer to the "brass tacks," the power plant.

We will go far before we can discover an individual who measures down to the pitiful figure depicted above, but—

More stiffening up of the backbone is highly necessary these days; the backbone is the invisible tail to the brain, and in this instance the "tail should wag the dog."

To succeed, the operating engineer must be an energetic, thinking, confident man; the hesitating, indifferent and careless man is being crowded to the wall, and the demand for his services will soon be small indeed.

In these free and glorious United States it is our proud boast that one man is as good as another. Oh, no, he isn't! It is the jellyfish kind that cannot stiffen up. It is the one with the backbone who does things.

An operating man may say, when a level-headed chap has approached the old man and told him how a dollar here and there could be saved by some inexpensive change of operation, or by adopting a new device seen in another plant: "Why, I knew that; I could have told the boss that much, but I did not want to butt in; it is none of my business."

It *is* his business, and right here is where he *should* butt in, and butt in hard!

Owners and managers are constantly complaining that they hire engineers to operate their plants who hold aloof and seem afraid or unwilling to open their mouths.

Open your mouth, then say something! The boss will not eat you up or discharge you if you will but hook up your backbone, increase your mental pressure and "pull her wide open." Jack up your spine, throw out your chest, square your shoulders, then dig out for the old man. He will be glad enough to see you if you have something to offer.

Produce something!

Frankly, is it not because some of us fail to produce something of benefit to good operating practice that we figure very small in the estimation of the owners? To be a good detail man is all very well, but the performer of details—the usual routine duties that are taken as a matter of course—generally goes unrecognized and gets lost in the midst of them.

Right this minute, you may have a good economical scheme tucked away just above your spinal column. Stiffen up, and out with it to the old man!

Extension of Redondo Beach Plant

By A. R. Maujer

Two 15,000-kilovolt-ampere high-pressure turbines have been installed without enlarging the engine house. The circulating-water system has been enlarged and redesigned so that a continuous and ample cooling-water supply is permanently assured.

To satisfy the increased demands for current resultant from the natural growth in the section served, an extension of the Redondo Beach generating station of the Pacific Light and Power Corporation has just been completed. Redondo beach is about 20 miles southwest of Los Angeles. Although much of the power generated in this station is used in Los Angeles, the beach is an advantageous location for the plant because of the availability of sea water for condensing purposes. The difficulty and expense of obtaining sufficient water for this purpose in Los Angeles more than offset the losses due to the additional distance of transmission.

The original generating equipment of the Redondo plant was fully described in POWER for September 15, 1908. Briefly, it is as follows: Three 5000-kilowatt General Electric dynamos direct driven by McIntosh & Seymour double horizontal-vertical compound condensing engines, 34 and 70 by 56 inches in size, running at 100 revolutions per minute. Steam for the engines is generated in Babcock & Wilcox boilers and delivered at 175 pounds gage pressure and a superheat of about 100 degrees Fahrenheit.

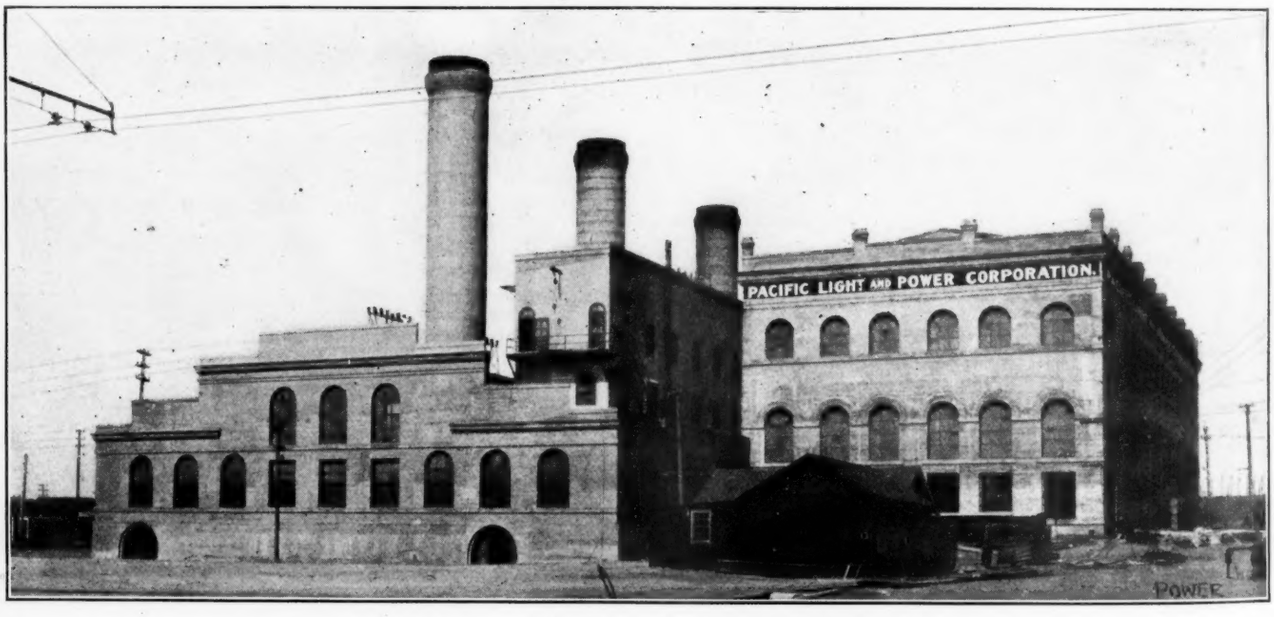


FIG. 1. THE REDONDO BEACH STEAM-GENERATING STATION

Each engine is served by two Wheeler "Admiralty" condensers which are drained by motor-driven Wheeler-Edwards pumps.

After a careful inspection of the plant and its equipment and a thorough analysis of the operating conditions, the consulting engineers, J. C. White & Co., Inc., of New York City, decided to recommend high-pressure turbines. The possibilities of exhaust-steam turbines were considered, and, in view of the showing made by the exhaust-steam turbine installation at the Fifty-ninth Street station of the Interborough Rapid Transit Company, of New York, and the similarity in the physical characteristics of the Redondo and the Fifty-ninth Street plants, it was anticipated by many that the exhaust-steam turbine would be selected. The single factor which determined the selection of the high-pressure turbine was the necessity of having the power for use within the shortest possible time. High-pressure turbines meant the quickest job; then, too, if exhaust-steam turbines had been selected, it would have been necessary to alter the cylinder ratio of the engines. This means that one engine would have been completely out of service for a considerable time, and this was entirely out of the question, for the load was very close to the station capacity.

It is possible that exhaust-steam turbines may yet be installed in connection with the reciprocating-engine part of the station's equipment.

The extension of the plant compelled remodeling and enlarging the circulating-water system. In the original layout the circulating pumps were in a pit at the west end of the engine room. These pumps were removed and the new ones were placed in a separate house down on the beach, and in the space made vacant by the removal of the old pumps, two 15,000-kilovolt-ampere Curtis vertical turbo-generators with their auxiliaries were installed. Thus the original capacity of the station was virtually trebled without extending the engine-house building lines.

TURBO-GENERATORS

The turbo-generators run at a speed of 750 revolutions per minute and generate 50-cycle three-phase current at 9000 volts. The voltage is stepped up through autotransformers to 18,000 volts, the pressure at which it is transmitted to the substations. Autotransformers are cheaper in first cost, and in cases where there is a simple voltage ratio as in the present instance, where it is 2 to 1, they are more efficient than the usual static sets. The new exciter, which is a four-pole 100-kilowatt machine, is driven by a Curtis two-stage noncondensing horizontal turbine running at 2400 revolutions per minute.

The oil for the bearings is pumped by three Dean horizontal duplex pumps, two for normal operation and one spare. Two pumps are provided for the oil for the guides and governors; one for normal operation and one reserve.

Condensers

The condensers are of the surface type and are built in two sections; the main or base section, directly underneath the turbine, contains 16,000 square feet of condensing surface; the auxiliary section forms an extension at one side of the main section and contains 8000 square feet of surface. The condensers and the wet- and dry-vacuum pumps were supplied by the Alberger Condenser Company. The condensate is removed by a 5-inch motor-driven centrifugal pump. There is also a turbine-driven unit of the same size for emergency use. The dry-vacuum pumps are steam-engine driven, 10 and 30 by 24 inches in size.

screens to exclude kelp and other marine growths from the condensers.

In the southern latitudes submarine-plant life is extremely varied and prolific and consequently there is always a vast quantity of leaves, weeds, etc., in the water. With this original arrangement of the intake pipes, these growths were sucked against the screens and frequently were pulled through into the pumps. As a result, the condensing system was often completely out of service in spite of the fact that there were duplicate suction pipes, one of which was always available for cleaning. It was many times found impossible to clean one pipe and get it back into service rapidly enough to relieve the other pipe before

turbine designed to run condensing, however, approximately 50 per cent. of the work is done by the expansion of the steam below the atmospheric pressure, and the loss of the vacuum would mean that a large part of the load would have to be taken off.

The new circulating-water system at the Redondo station differs radically in design from the original one. With the old system the circulating-water pumps were connected direct to the long intake siphons and these contained the screens. Thus the water passed through the screens under pressure, and once a bit of seaweed caught against the screens there was little chance of its floating free again until the suction was taken

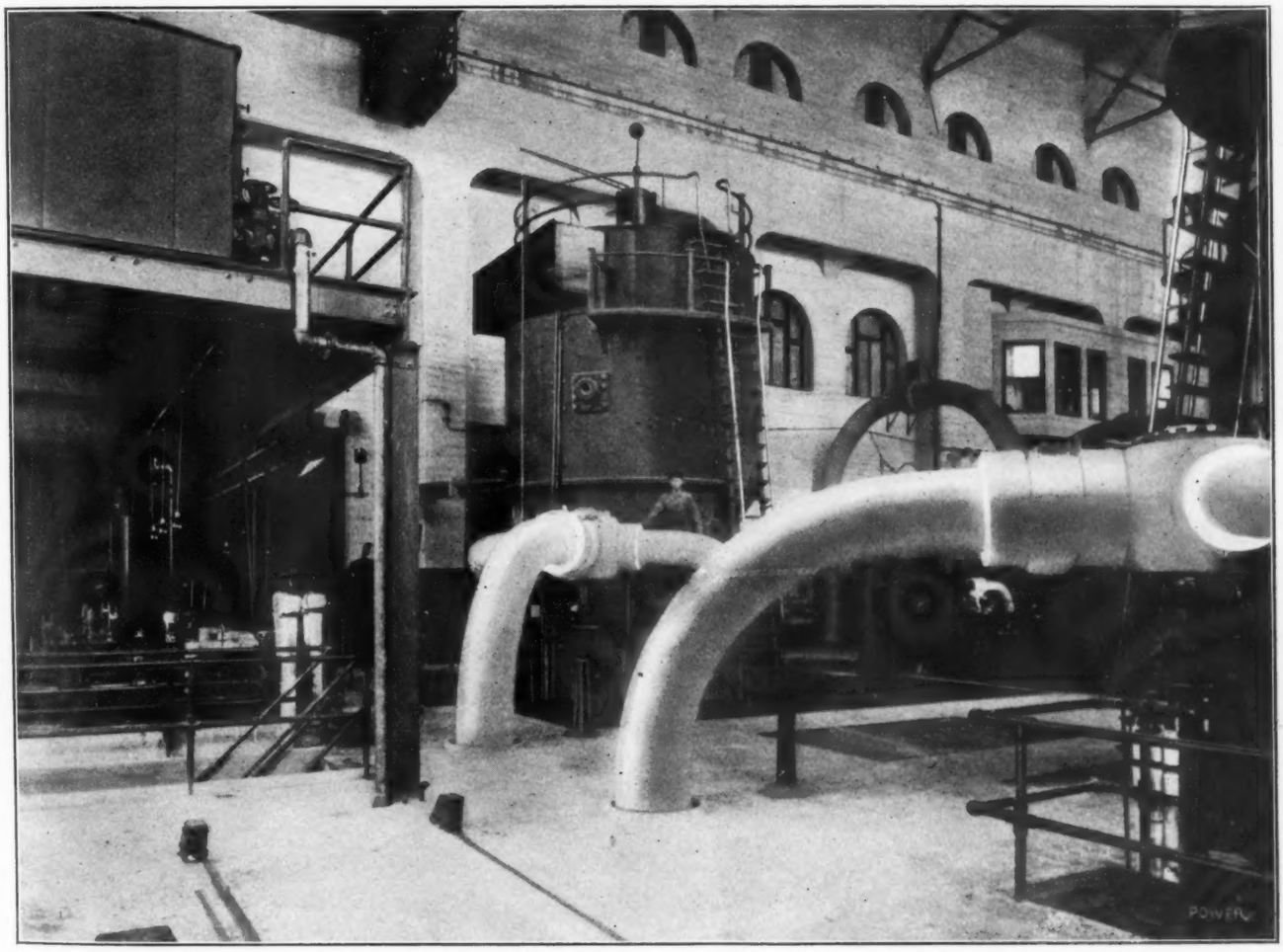


Fig. 2. Partial View of Generator Room, Showing One of the New Units

Circulating-water System

Originally, the circulating water was drawn through either or both of two 50-inch riveted-steel suction pumps some 1300 feet long to the three pumps. These forced it through the condensers from which it was discharged through a 50-inch return line of construction similar to that of the intake pipes. The suction lines extended out from the shore about 7000 ft. At the shore each line connected into a large cylindrical chamber containing a set of

it became so badly fouled and the circulating-water supply so reduced that it was necessary to divert the engine exhaust to the atmosphere.

Continuity of condensing-water supply is most important in the case of a turbine installation. A reciprocating engine, which normally operates condensing, is capable of carrying at least its rated load even when the vacuum is lost, as less than 25 per cent. of the work is done by the expansion of the steam below the atmospheric pressure. With a

off. In the present system the siphons discharge into an open screen basin containing racks and screens of ample area and so arranged that cleaning is easily accomplished; the water is cleared of the seaweed under atmospheric pressure alone. Fig. 3 shows the general arrangement of the intake portion of the present circulating-water system. The new house which contains the circulating-water pumps is located close to the shore line of the beach. On its seaward side is the screen basin in which the pump-

suction pipes extend and from which the siphon pipes are carried some 950 feet out on a reinforced-concrete pier to deep water. The siphon pipes are 54 inches in diameter and are built of ½-inch steel plates. The longitudinal lap seam is double riveted with ¾-inch rivets on 2¼-inch centers. The circumferential lap seams are single riveted with ¾-inch rivets on 1⅞-inch centers. At their sea ends the siphons connect into seven 26-inch suction nozzles 22 feet long, spaced as shown in Fig. 3. The total area of the suction pipes is over 50 per cent. greater than that of the main pipe, and consequently the velocity of the water as it enters the intake nozzles is low. This prevents undue agitation of the water in the vicinity of the intakes, and therefore less seaweed gets into the siphons than would otherwise be the case. The screen basin is built of reinforced concrete. It is 58 feet long, 52 feet wide and 31 feet deep from the top of the side walls. Two partition walls extend across the basin at equal distances from the ends and divide it into three bays of equal size; one siphon and one pump-suction pipe enter each bay. These walls, being inverted trusses, strengthen the bottom of the basin, which rests on quicksand, and provide suitable means of holding the screens and racks in place, which are thus made in sizes small enough to be handled with facility. Two holes in each wall serve to keep the water level equal in all of the bays and thus prevent any lateral strain on the walls.

The water is induced to flow into the screen basin after the manner of a natural siphon. A vacuum-pump line for keeping the siphons free of air is connected through an 8-inch nozzle to each line at *A*, Fig. 3. Several motor-driven vacuum pumps of assorted sizes, which are in the pump house, are connected to this line. One of the large pumps is used for starting the water. During normal operation a small pump, driven by a 15-horsepower motor, has ample capacity to keep the pipes free from air. The siphons will run approximately two hours without any assistance whatever from the vacuum pumps.

The air tap from the siphon is carried up vertically for 34 feet, so as to eliminate the possibility of the vacuum pumps pulling over a slug of water into their cylinders and wrecking themselves. All of the entrained moisture in the air is removed by a Cochrane separator at the top of the air seal. The vacuum piping is in duplicate.

In the screen basin the water first passes through sets of iron racks, inclined at an angle of about 45 degrees to give plenty of submerged surface. These racks are made of 3x¼-inch iron bars placed ⅞ inch apart. Behind the racks are two sets of vertical screens and provision has been made for a third set. The front set is made of No. 8 galvanized-iron wire cloth of ⅞-inch mesh, and the rear set of No. 10 wire with ½-inch mesh. The framework of the screens is made of angle iron. The screens fit into slots and are provided with rings in their upper edges so that they may be raised easily by the small electrically operated traveling crane shown in Figs. 3 and 5. When a screen becomes fouled it is raised, swung in front of the splash board, also shown in Figs. 3 and 5, and flushed off from the back with a hose. A trough at the bottom of the frame catches any seaweed that may fall from the surface of the screen and prevents it from getting back into the water on the suction side of the screens. The seaweed and the cleaning water fall into a trough and drain off outside the screen basin, the flow being helped by the discharge from a 6-inch centrifugal sand pump. The suction of this sand pump is placed on the bottom of the screen basin in such a manner that whatever sand is brought in through the siphons is promptly removed. By this arrangement a screen can be raised, cleaned and replaced in a very short time with but a small expenditure of labor.

Water for flushing off the screens is supplied by a 10 and 5 by 10-inch Worthington duplex pump controlled by a Fischer governor and placed as shown in Fig. 3. This pump also supplies water for the 30-inch hydraulically operated valves on the circulating-water pumps. In case of emergency these valves may be operated by water from the boiler-feed pumps.

The circulating water enters the pumps through 36-inch lap riveted-steel suction pipes. The pumps are of the double-suction centrifugal type and were built by the G. W. Price Pump and Engine Company. The diameter of the inlet is 32 inches and that of the discharge 30 inches. Each pump is capable of passing 24,000 gallons of water per minute against a total head of 40 feet when working at a speed of 225 revolutions per minute. The pumps are driven by Fleming-Harrisburg tandem-compound noncondensing side-crank engines, 16

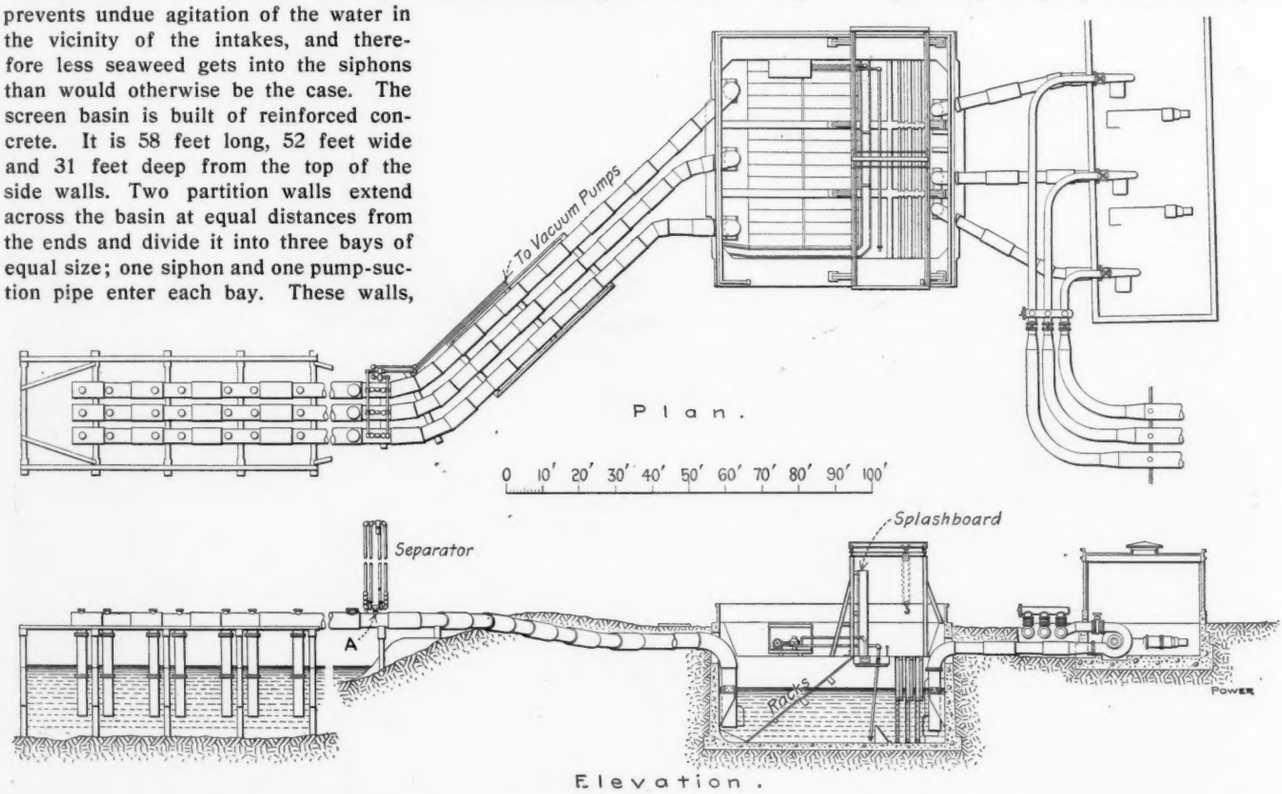


FIG. 3. SHOWING GENERAL ARRANGEMENT OF SIPHONS AND SCREEN BASIN

and 27 by 18 inches in size, controlled by Gardner throttling governors. These engines are rated at 400 horsepower each.

There are three 50-inch reinforced-concrete circulating-water pipes, one for each turbine unit and one for the three engines. Just outside the pump house these pipes are so interconnected by a manifold that the discharge from any pump may be put through any line. The circulating-water discharge from the various condensers is collected in an 11 by 18 by 20-foot concrete hotwell from which the water flows away by gravity through a reinforced-concrete duct 5 feet square.

The exhaust from all of the auxiliaries, including the circulating water-pump engines, is piped to the two new 10,000-horsepower Cochrane open feed-water heaters which are on a gallery in the new part of the boiler house, as shown in Fig. 7.

The square concrete tank on the floor in the foreground of Fig. 7 is an auxiliary hotwell. Originally the condensate from the McIntosh & Seymour engines was discharged into individual hotwells from which it was pumped to the heaters as needed. In cases of sudden overload on the engines these hotwells would overflow to the sewer and considerable good water was lost thereby. To avoid this, the auxiliary hotwell was provided, and now the condensate is collected here and then pumped to the heaters. The overflow from the heaters is also received by this hotwell so that no water suitable for boiler feed is wasted.

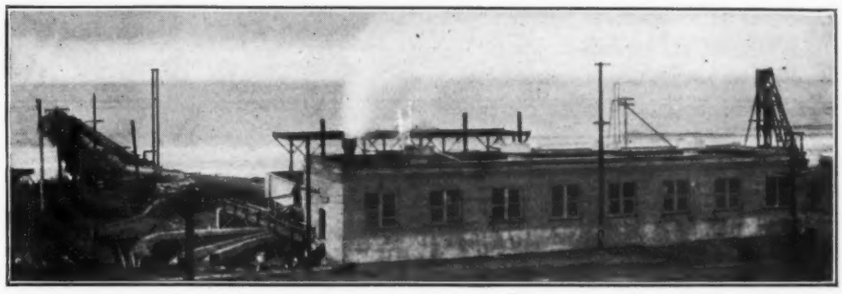


FIG. 4. BIRDSEYE VIEW OF PUMP HOUSE, SCREEN BASIN AND SIPHONS

NEW BOILERS

To provide the extra steam required for the two new generating units, provision was made for the installation of eighteen 600-horsepower Stirling water-tube boilers. Eight of these boilers have been erected so far and the erection of the remainder will be completed in the immediate future. To accommodate this additional boiler equipment it was necessary to extend the boiler house approximately 100 feet and erect a chimney similar in design and equal in size to the two old chimneys. The new chimney, of reinforced concrete, is 125 feet high and has an internal top diameter of 13 feet. The new boilers are fitted with Babcock & Wilcox superheaters which give the steam a superheat of 100 degrees. Three Hammel back-shot fuel-oil burners are used under each boiler in Hammel furnaces. The burners under the new boilers are hand regulated while those under the original boilers, also of the Hammel make, are all automatically controlled by the system devised by C. C. Moore & Co. Thus

FIG. 5. LOOKING INTO SCREEN BASIN

the new boilers are set to work at their most economical rate, while the old automatically controlled boilers take care of the load fluctuations.

Piping

The high-pressure piping is constructed of full-weight steel pipe with Van Stone joints of forged steel. Long-radius bends are used throughout the entire high-pressure steam-piping system. All of the high-pressure steam-pipe fittings are of cast steel. The boiler-feed and boiler-washing piping are built of cast-iron pipe having a wall thickness of ¾ inch. The blowoff-pipe lines are of full-weight steel. The boiler-feed pumps are of the usual duplex type.

Value of a Vacuum

For some weeks a discussion has been running in *The Engineer*, of London, upon the value of a vacuum, induced by a paper by Mr. Morison, whose recent work upon the condenser has been several times referred to in our columns. Mr. Morison in his paper rather questioned the current opinion of marine engineers, that it is better to run on a low than a high vacuum, and in an editorial review of the discussion *The Engineer* reaches the conclusion that Mr. Morison has proved his case, and that in all but a small percentage of ships good vacuums are worth having. In the best practice, however, the gain can be but little. If the price to be paid for the apparatus required to utilize the auxiliary exhaust and get rid of air from the condenser is small, then the capital outlay may be regarded as a good investment. The first thing to be demonstrated was that hot feed water and a good vacuum may go together. Of this there is no longer any doubt.

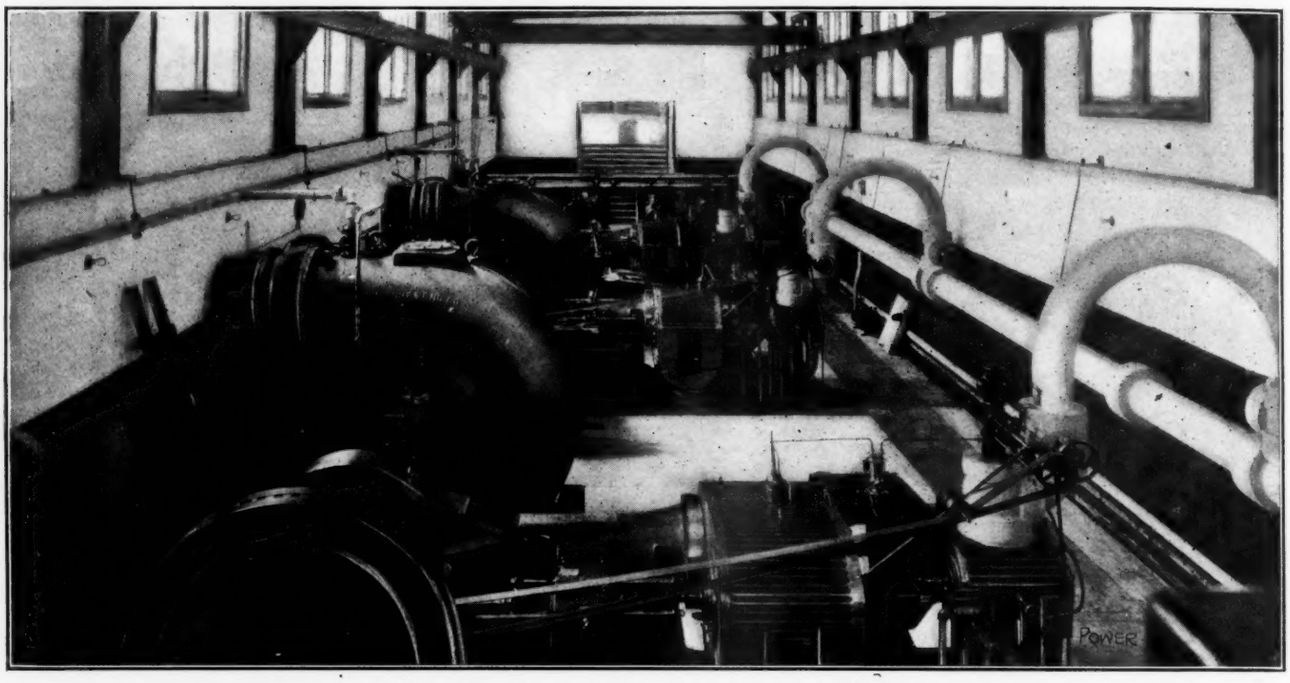


Fig. 6. Interior of Circulating-water Pump House

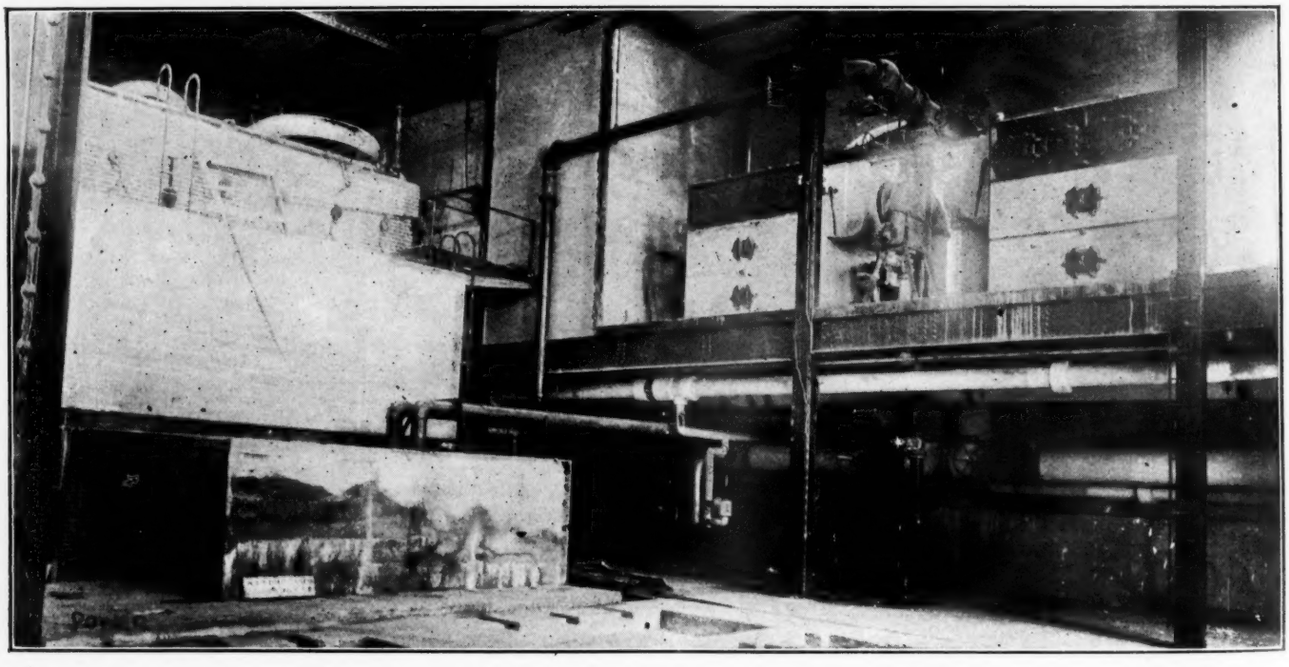


Fig. 7. The Feed-water Heaters and the Auxiliary Hotwell

Bleeding Receiver to Heat Feed Water

Computations showing how a saving of 4.74 per cent. of the heat in the steam may be saved, theoretically, by using steam from the receiver to raise the feed-water temperature from 100 to 210 degrees Fahrenheit.

A correspondent submits the following inquiry:

"I have a 22 and 44 by 72-inch tandem-compound engine. The steam pressure is 140 pounds, gage; the vacuum is 25 inches. The engine runs at 61.5 revolutions per minute carrying a load of 670 indicated horsepower. The receiver pressure is 9 pounds, gage. The temperature of the feed water is 100 degrees. Can I install a heater and use steam from the receiver to raise the water to 210 degrees for 850 boiler horsepower, and what would be the saving in coal?"

Assume the required evaporation to be

$$30 \times 850 = 25{,}500 \text{ pounds}$$

at 155 pounds absolute.

To make a pound of steam at this pressure from water at 32 degrees would require 1194 heat units. To raise a pound of water from 32 to 100 requires 67.97 heat units. To make a pound of steam therefore at 155 pounds absolute from feed water at 100 degrees would take

$$1194 - 67.97 = 1126.03 \text{ B.t.u.}$$

and to make the 25,500 pounds required would take

$$25{,}500 \times 1126.03 = 28{,}713{,}765 \text{ B.t.u.}$$

all of which with the feed water at this temperature the coal would have to furnish.

In the absence of indicator diagrams assume that with the given receiver pressure of 9 pounds, gage, or 24 pounds absolute, the steam when it gets to the receiver has done one-half of the work which it is capable of doing; that is, that it will do as much work in the low-pressure cylinder as it has already done in the high. Assume that the engine requires 15 pounds of steam per indicated horsepower-hour, that the cylinders are equally efficient and that the steam as it enters the high-pressure cylinder is dry saturated.

One horsepower-hour is 1,980,000 foot-pounds, or

$$\frac{1{,}980{,}000}{777.5^2} = 2546.6 \text{ B.t.u.}$$

Each pound of steam then gives up as work in the whole engine

$$2546.6 \div 15 = 170 \text{ B.t.u. (approx.)}$$

and in the high-pressure cylinder one-half as much or

$$170 \div 2 = 85 \text{ B.t.u.}$$

One pound of dry saturated steam at 155 pounds absolute contains 1194 Bt.u. Neglecting radiation, each pound would carry to the receiver

$$1194 - 85 = 1109 \text{ B.t.u.}$$

The "heat of the liquid" at the receiver pressure, 24 pounds absolute, is 206 B.t.u. This would leave

$$1109 - 206 = 903 \text{ B.t.u.}$$

available for evaporation.

The heat necessary to evaporate a pound of water at this pressure is 953.5 B.t.u. Therefore, only

$$\frac{903}{953.5} = 94.7 \text{ per cent.}$$

of the exhaust from the high-pressure cylinder can be steam, and less will be on account of radiation and conduction. In the receiver some of this moisture may settle out and be drained off, and the question may be complicated as to the use of these drips and the quality of the stuff taken out of the receiver. Let us consider the simplest case, taking the mixture from the receiver as it comes from the high-pressure cylinder, each pound containing 1109 B.t.u.

It is desired to raise the temperature of the water to 210 degrees. The heat in a pound of water of this temperature is 178 B.t.u. In passing to water at this temperature the pound of mixture which is taken from the receiver will give up

$$1109 - 178 = 931 \text{ B.t.u.}$$

To raise a pound of water from 100 degrees to 210 will take 110 B.t.u.

It will, therefore, take $\frac{110}{931}$ of a pound of the receiver mixture to heat a pound of the water the required amount.

But it is not necessary to heat the whole of the feed water 110 degrees. A part of it will be made up of the condensed steam at 210 degrees coming over from the receiver.

On the other hand, the boilers will have to evaporate more water because the steam taken from the receiver will have done only one-half of its work, and the boilers will have to supply one-half as much as is taken out in addition to what they have been supplying to make up for the loss of the work in the low-pressure cylinder.

Call the amount of 100-degree water necessary to be heated x.

Then, since $\frac{110}{931}$ of a pound of mixture will come out of the receiver for each pound of water heated, $\frac{110}{931}x$ will be the weight of the mixture taken from the receiver, and

$$x + \frac{110}{931}x$$

will be the total amount of water fed to the boilers. This must be 25,500 pounds plus one-half as much as is taken out of the receiver or

$$25{,}500 + \left(\frac{1}{2} \times \frac{110}{931}x\right)$$

so that

$$x + \frac{110}{931}x = 25{,}500 + \frac{110}{2 \times 931}x$$

$$x + \frac{110}{931}x - \frac{110}{2 \times 931}x = 25{,}500$$

$$x\left(1 + \frac{110}{931} - \frac{110}{931 \times 2}\right) = 25{,}500$$

$$x = \frac{25{,}500}{1.059085} = 24{,}077 \text{ pounds}$$

Let us see how this comes out:

24,077 pounds to be heated
110 B.t.u. per pound
B.t.u. from receiver per lb. 931) 2,648,470 B.t.u. needed
2,845 pounds from receiver
24,077 new water
26,922 tot l

The boiler now has to evaporate 26,922 pounds of water at 210 degrees into steam at 155 pounds

Total heat at 155 pounds =	1194
Heat of liquid at 210 degrees =	178
B.t.u. required per pound =	1016

The fuel will have to supply then

$$26{,}922 \times 1016 = 27{,}352{,}752 \text{ B.t.u. per hour}$$

In the original condition it had to supply 28,713,765.

The difference:

$$28{,}713{,}765 - 27{,}352{,}752 = 1{,}361{,}013$$

is

$$\frac{1{,}361{,}013 \times 100}{28{,}713{,}765} = 4.74 \text{ per cent.}$$

In case of low water, smother the fire immediately with green coal. Close the ashpit doors. Open the damper, allowing cool air to draw through the furnace and tubes. Leave the engine running until pressure is reduced to the lowest possible point. If the feed pump is running let it run as long as it will. When the pressure will no longer run the engine or pump, it may be still further reduced by opening the gage cocks and the water-column drain valve. When the pressure has been reduced to near the atmosphere, water may be let in to the usual hight and a search made for leaks or signs of overheating.

Mean Pressure of Expanding Steam

By Albert E. Guy

By means of the alinement chart herein given, it is possible to read directly the value of the expression for the mean pressure when the initial pressure and the number of expansions are known.

To estimate the work done by steam in a cylinder working at full pressure against a piston during part of the stroke and then, being cut off from the boiler supply, expanding for the remainder of the stroke, it is necessary to know the average or mean pressure exerted against the piston throughout the stroke. If A is the area of the piston in square inches, L the length of stroke in feet, and pm the mean pressure in pounds per square inch, the work done for one stroke is

$$W = A \times L \times pm \text{ foot-pounds}$$

The value of the mean pressure is obtained by the formula

$$pm = p_1 \left(\frac{1 + \text{hyperbolic log. } r}{r} \right) \quad (1)$$

in which

p_1 = Absolute initial pressure;
pm = Absolute mean pressure;
r = Number of expansions, or

$$= \frac{\text{Volume after expansion}}{\text{Volume before expansion}}$$

Since one volume of boiler steam becomes r times larger at the end of the stroke, it follows that the cutoff is $\frac{1}{r}$.

The *effective* mean pressure, however, is not the pm given by equation (1); to obtain this, it is necessary to subtract from pm the absolute back pressure. Even then, there are many other factors which may affect its value, such as a variation of pressure in the receiver, friction in the steam ports and passages, initial compression at the beginning of the stroke, etc. To calculate the influence of these various elements would be laborious, involving many assumptions, and the result would be doubtful. Therefore, it is preferable to employ suitable constants derived from experience. These may be found in many engineering handbooks which also give tables of values for the expression $\left(\frac{1 + \text{hyperbolic log. } r}{r} \right)$. The alinement chart herein given, however, will be found to suit the purpose more closely than these tables; it gives the required mean pressure at one reading without any further calculations except, of course, those involved by the use of a coefficient of correction, as mentioned.

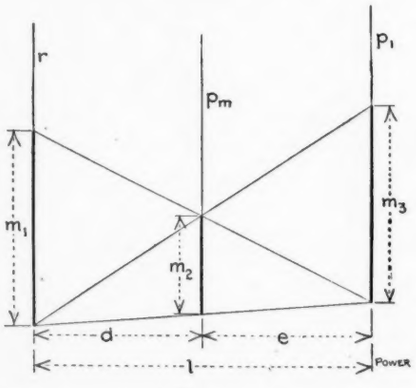


FIG. 1

It should be noted that $\frac{1}{r}$ represents the cutoff, but not that usually understood in engine practice. In the latter case

$$\text{cutoff} = \frac{\text{portion of stroke during admission}}{\text{full length of stroke}}$$

whereas,

$$\frac{1}{r} = \frac{\text{volume of steam before expansion}}{\text{volume of steam after expansion}}$$

If there were no clearance space these two values would be equal, but, actually

$$\frac{1}{r} = \frac{\left(\begin{matrix} \text{portion of stroke during admission} \\ + \text{clearance} \end{matrix} \right)}{\text{length of stroke} + \text{clearance}}$$

The scales of r and $\frac{1}{r}$ in the chart do not represent the values of r and $\frac{1}{r}$, but instead the value of $\left(\frac{1 + \text{hyperbolic log. } r}{r} \right)$ for a given value of r. Thus where r equals 10, the chart reading represents in reality the value of 0.3303.

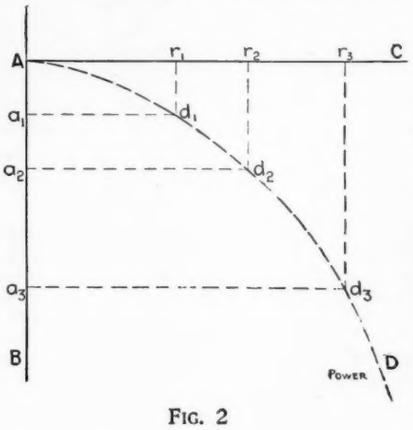


FIG. 2

*See April 4 issue of POWER.
†See June 6 issue of POWER.

The modulus* m_1 for the r scale was chosen 250 millimeters, the same length being suitable for the modulus m_3 of the scale of p_1.

Equation (17)† gives for the modulus m_2 of the pm scale:

$$m_2 = \frac{m_1 m_3}{m_1 + m_3}$$

And since $m = m_3$,

$$m_2 = \frac{m_1^2}{2 m_1} = \frac{m_1}{2} = \frac{250}{2} = 125 \text{ millimeters}$$

The chart is constructed as in Fig. 1.

$$\frac{d}{e} = \frac{m_1}{m_3} = 1$$

The pm scale is therefore exactly equidistant from the other two. For p_1 the scale of numbers on a 10-inch slide rule can be used, and for pm the scale of squares on the same rule.

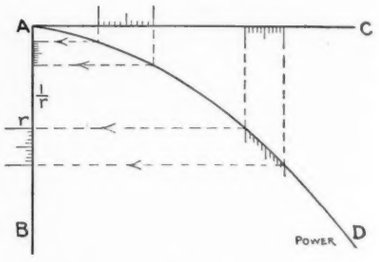


FIG. 3

The scale of r was determined as follows: On the line $A\,B$ (Fig. 2) and from A as an origin, the logarithmic lengths $A\,a_1$, $A\,a_2$, $A\,a_3$, etc., were laid off, being the values of the expression $\left(\frac{1 + \text{hyperbolic log. } r}{r} \right)$ for different values of r, respectively r_1, r_2, r_3, etc. Then on $A\,C$ normal to $A\,B$, and from A as an origin, the logarithmic lengths of r_1, r_2, r_3, etc., were laid off, and the rectangular coordinates $a_1\,d_1$ — $r_1\,d_1$, $a_2\,d_2$ — $r_2\,d_2$, $a_3\,d_3$ — $r_3\,d_3$, etc., drawn as shown. This determined exactly the points of intersection d_1, d_2, d_3, etc., through which the curve $A\,D$ was made to pass.

A sufficiently large number of intersections was plotted so as to insure the correctness of the curve. The remainder of the work required only close attention and patience, it being altogether mechanical. Fig. 3 shows how the scales were transferred from $A\,C$ to the curve $A\,D$, and thence to $A\,B$.

The scale of initial pressures extends from 25 to 250 pounds. Should a higher pressure be used, as 360 for instance, with r equal to 10, a straight-line index place on 10, on the r scale, and on 36, on the p_1 scale, will determine on the pm scale a mean absolute pressure of 11.9 pounds, which multiplied by 10 (since $36 \times 10 = 360$) gives 119 pounds as the required mean pressure.

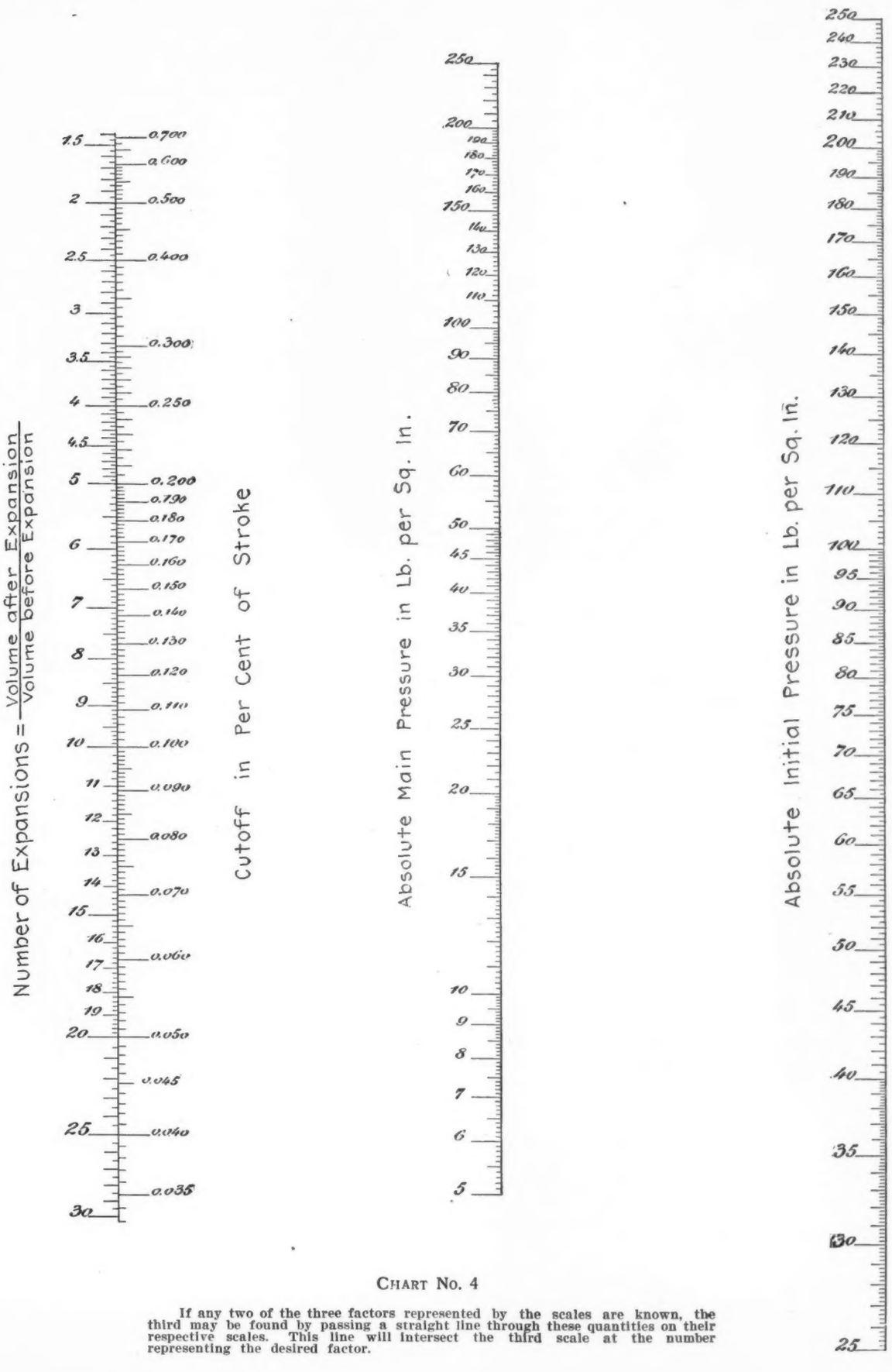

Number of Expansions = Volume after Expansion / Volume before Expansion
Cutoff in Per Cent of Stroke
Absolute Main Pressure in Lb. per Sq. In.
Absolute Initial Pressure in Lb. per Sq. In.

CHART NO. 4

If any two of the three factors represented by the scales are known, the third may be found by passing a straight line through these quantities on their respective scales. This line will intersect the third scale at the number representing the desired factor.

Errors of Indicator Reducing Rigs

By E. S. Libby

In an effort to make the indicator produce a diagram which represents exactly the motion of the piston within the cylinder, many forms of reducing motion have been devised. The shortcomings of some of these are herein pointed out.

The indicator is an instrument which will give a graphic representation of the whole cycle on one side of the piston, thus permitting a study to be made of all the variations of pressure and volume through the stroke and giving a means of calculating the work done by the steam upon the piston.

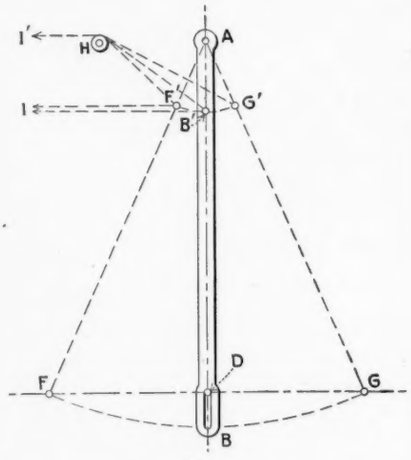


Fig. 1

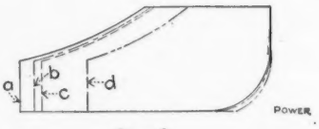


Fig. 2

LEVER REDUCING MOTION AND DIAGRAMS COMPARING ERRORS DUE TO ITS USE

To obtain an exact representation of the conditions on the inside of the cylinder it must exhibit with precision the pressure of the steam within the cylinder at every instant throughout the stroke, and simultaneous measures must be given of the position of the piston corresponding to the given pressure each instant; the diagram produced must be made so as to have its ordinates exactly proportional to the steam pressure and its abscissas proportional to the motion of the piston.

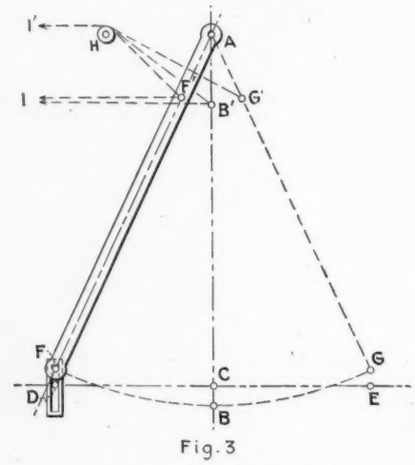


Fig. 3

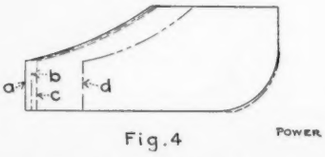


Fig. 4

LEVER WITH SLIDING-PIN CONNECTION AND THE DIAGRAMS SHOWING ERRORS

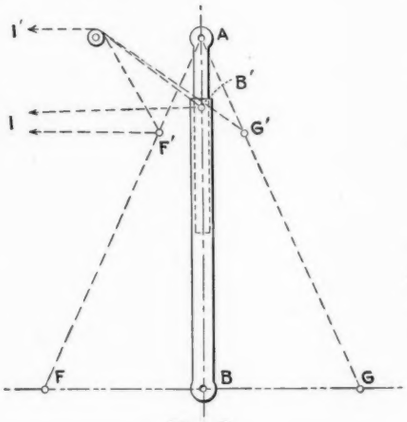


Fig. 5

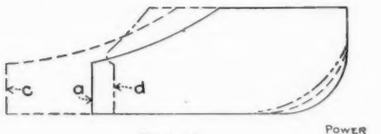


Fig. 6

TELESCOPING LEVER AND DIAGRAMS SHOWING ERRORS

In obtaining an exact reproduction of the motion of the piston the reducing motion must be so designed as to impart to the drum of the indicator a motion proportional to that of the piston.

The reducing motion is made in many ways and is often improvised for the occasion by ingenious engineers. The accompanying sketches illustrate some of the different rigs used.

The reducing motion shown in Fig. 1 consists of a lever *A B*, slotted at the lower end, which permits the pin *D* in the crosshead to work up and down as the crosshead travels from *F* to *G*. The indicator cord is attached to the point *B'* and may be led direct to the indicator or over a pulley *H* to the indicator.

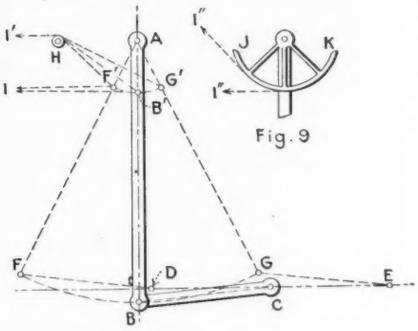


Fig. 7

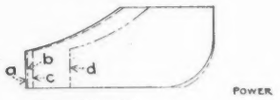


Fig. 8

JOINTED LEVER, BRUMBO PULLEY AND DIAGRAMS SHOWING ERRORS

In all motions of this kind there is a radical defect due to the fact that while the crosshead moves in a straight line, any point on the lever swings through an arc of a circle. With this reducing motion the error produced is illustrated in Fig. 2.

The diagram *a* represents the true diagram; *b* the diagram obtained if a sector were substituted as in Fig. 9, in place of running direct from the pin *B'*. This shows an error of 0.95 per cent. too high in mean effective pressure. The diagram *c* represents that taken without a sector but running direct to the indicator. The cord is usually so long that its angular motion is immaterial, showing an error of 0.6 per cent. too high in mean effective pressure. If, however, the cord is run over a pulley as at *H*, the distortion

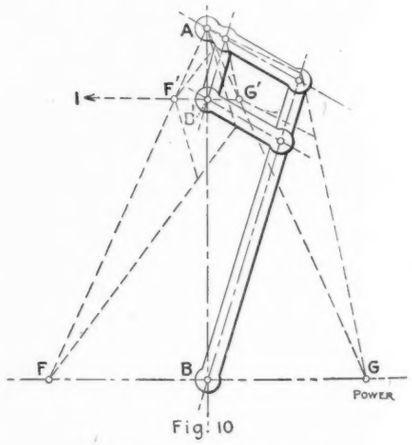


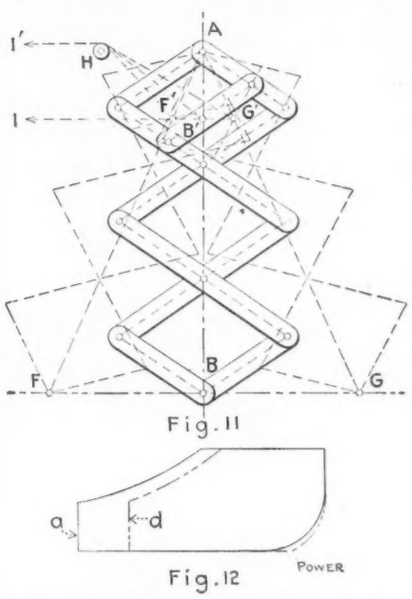
Fig. 10

PANTOGRAPH REDUCING RIG

will be quite marked, as will be seen by the diagram *d* which shows an error of 1.5 per cent. too low in mean effective pressure.

The motion illustrated in Fig. 3 is the same as that shown in Fig. 1 with the exception of the slot, which is on the crosshead, the length of the lever remaining constant. With this reducing rig the errors introduced by its use are illustrated in Fig. 4.

The diagram *a* is the true one; *b* made as before, with the sector, shows an error of 0.68 per cent. too low in mean effective pressure; *c* made as before, without the sector but with the cord running direct to the indicator, shows only 0.25 per cent. too low in mean effective pressure; *d*, with the cord running from the pin *B'* over the pulley *H* to the indicator, shows



ANOTHER FORM OF PANTOGRAPH AND CORRESPONDING DIAGRAMS

an error of 2.7 per cent. too low in mean effective pressure.

In Fig. 5 the reducing motion is a combination of the two already explained. Here the top part is permitted to slide inside of the lower part. With this form of motion it will be seen that the error is more marked.

In Fig. 6, *a* represents the true diagram as before; *c* the diagram obtained by running direct to the indicator drum. Here there is an error of 4.8 per cent. too low in mean effective pressure. If the cord is run over the pulley and then to the indicator the diagram *d* is obtained with an error of 7.4 per cent. too high in mean effective pressure.

The rig shown in Fig. 7 is known as the brumbo pulley and is probably used more than any other form, especially these already illustrated. The diagrams obtained with this motion are shown in Fig. 8, *a* being the true diagram, *b* that obtained with the use of the sector, showing an error of 0.55 per cent. too high in mean effective pressure, *c* being the diagram obtained without pulley or sector, showing no error which could be measured and that would affect the mean effective pressure. The diagram *d* is obtained by running the cord from the pin over the pulley to the indicator, and it shows an error of 0.95 per cent. too low in mean effective pressure.

Figs. 10 and 11 represent two well known forms of pantograph, which give an exact reproduction of the motion of the piston, provided the indicator cord is run parallel to the path of the piston. If the cord is not run from the pantograph parallel to the piston but run over a pulley, as shown in Fig. 11, we have the results shown in Fig. 12 by diagram *d* which shows an error of 2.3 per cent. too high in mean effective pressure.

The amount of distortion varies also with the location and the size of the pulley *H*. The larger the pulley the more distortion, and the higher the pulley is above the point of suspension *A*, the more distortion. If the pulley were placed directly above and at an infinite distance from the point *A* the motion would be zero.

The foregoing is based upon the following data: Stroke of engine, 18 inches; distance of the point *A* above the center line of engine, 20 inches; distance between *A* and *H*, 6 inches, and diameter of pulley *H*, 6 inches.

Speed versus Economy of Engines

BY VINCENT CLARKE

Engine builders often find that specifications call for a piston speed or a certain number of revolutions per minute lower than the standard adopted. The standard line of engines is usually decided upon after careful consideration in order to get the most economical type, and when dealing with inquiries for engines not coming within this range the standard engine is usually offered at a suitable speed.

For example, a 400-horsepower engine may be required to run at a speed of 90 revolutions per minute. If the standard line of engines were of the medium-stroke type and there were no restrictions regarding the speed, the engine builder would offer a 15 and 25 by 27-inch engine at a piston speed of about 800 feet per minute, or 170 revolutions per minute. As the speed is limited to 90 revolutions per minute this engine would not develop the power, and the suitable standard size would be an 18½ and 31 by 33-inch engine.

This engine would be designed for a piston speed of about 800 feet per minute and about 150 revolutions per minute. Hence the maker would have to offer an engine running at 40 per cent. below the speed for which it was designed. If the steam consumption of this engine must be guaranteed under these conditions, then the effect of diminishing the speed has to be considered.

So far as the writer is aware, the only published information on the effect of the speed of rotation on the economy of an engine are the tests made by P. W. Willans and recorded in volume 114 of the *Proceedings* of the Institution of Civil Engineers; the actual figures of the tests were 17.3 pounds per indicated horsepower per hour when running at 400 revolutions per minute, and 17.6 pounds when running at 300 revolutions per minute. Thus for a 25 per cent. de-

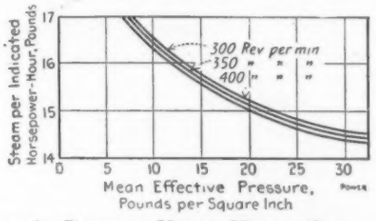


FIG. 1. RESULTS UP TO 25 PER CENT. DECREASE IN SPEED

crease in the speed of rotation there was an increase of 1.7 per cent. in the steam consumption.

The writer recently conducted some tests with a double-acting engine to observe the effect of the speed of rotation upon its economy. The engine was of the triple-expansion type, the cylinders

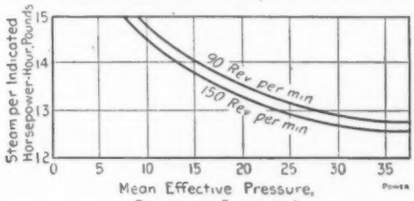


FIG. 2. RESULTS WITH 40 PER CENT. VARIATION IN SPEED

being 12½, 18½ and 30½ by 12 inches, and the range of speeds covered all those which were likely to be required.

Fig. 1 shows the results in pounds of steam per ind cated horsepower per hour plotted against mean effective pressure. From this it is seen that with a 25 per cent. decrease in the speed of rotation there is about 1.5 per cent. increase in the steam consumption, this increase being practically constant at all loads.

The writer recently gave a close steam-consumption guarantee, under penalty, for an engine under conditions similar to the foregoing example, and noted the effect of this 40 per cent. variation in speed upon the economy.

This engine was expansion-governed, and tests were made at three different loads at 150 and at 90 revolutions per minute. The results of these tests are shown in Fig. 2. With the 40 per cent. decrease in speed the steam consumption increased 2 per cent, this increase being practically constant at all loads.

The Price Water Current Motor

A device, consisting of a floating flume carrying submerged water wheels with hinged vanes and designed to convert the energy of flowing streams into useful power. At present, however, it has materialized only to the extent of a model and its achievements are based entirely upon the inventor's claims.

Into various models of the "wave motor" many American dollars have found their way; the subject of fuelless and so called perpetual power generation surely appeals to a certain class of investor. The "wave motor" now seems destined to be relegated to obscurity by a sister invention—the "current motor"—hailed (by its promoters) as "the marvel of the age." With this device, we are told, all rivers and streams can easily be harnessed, we can develop power from such flowing waters with no fuel and with no expense after installation and perpetually, night and day, rain or shine, summer and winter. This sounds good, but—?

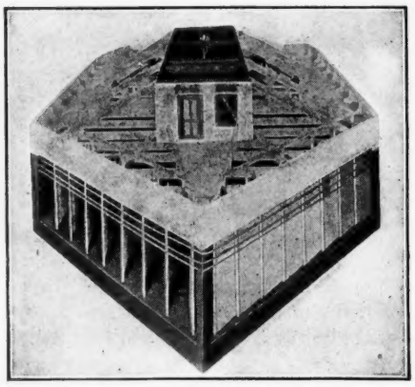


FIG. 1. FRONT VIEW OF MODEL

With a patent dated March 1, 1910, the Price Current Motor Company, of Los Angeles, has constructed a working model of its invention and placed it on exhibition for prospective investors. The current motor is shown in the accompanying figures. It lays claim to being the "most remarkable power invention ever conceived, destined to revolutionize present methods of generating current, and to make a fortune for its stockholders."

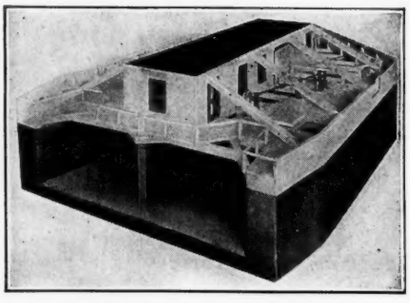


FIG. 2. REAR VIEW OF MODEL

The motor, based on water in streams carrying great power, is a floating flume device, rising and falling with the action of the current. It is anchored at the front in three places; by means of ballast in air-tight compartments, it can be submerged to a proper depth to suit the waterwheels *A*, Fig. 3. These wheels have hinged vanes which are positive in action, being placed, held and thrown out of position solely by the agency of the current, thus offering no noticeable resistance to motion on the one side. As shown, these four wheels transmit power, by means of the shafts *B* and *C*, Fig. 3, through a system of bevel gearing at *D* and *E*, actuating the flywheel *F*. The layout of the generating equipment, placed in a V-shaped house, is arbitrary with conditions—in this instance it is with countershaft drive to the generator (from working model). This apparatus may be constructed of wood or steel sheeting on a wood frame, as may be desired; its size it is presumed, is dependent upon stream conditions.

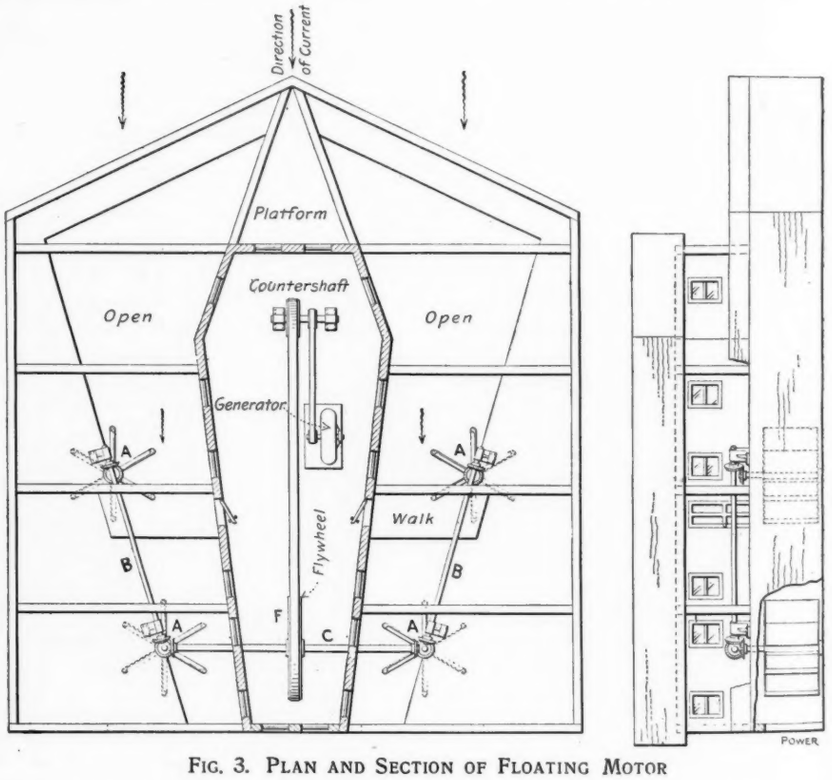


FIG. 3. PLAN AND SECTION OF FLOATING MOTOR

It is stated that no difficulty will be experienced with ice. First, the ballast mentioned will keep the wheels below the ice line; second, the motor is so constructed in front to act as a débris and ice deflector; third, the intake being about five times wider than the outlet, and the water traveling through the flume having a faster rate than the natural current, will have a tendency to keep the flume cleared; thus the same efficiency is attained in winter as in summer.

It may not be amiss to mention the reason why the public should invest in this enterprise (per the promoters), although this theme is getting time-worn through constant application:

"Because it will yield greater profits with less risk than any other enterprise that can be mentioned. Because of the larger profits and the immense dividends which must result therefrom, based on the great demand for it, that is sure to follow its introduction. Because the possibilities embodied in this enterprise are such that they will surprise the most optimistic. Because we now offer you a chance to obtain a safe investment, with the prospect that your outlay should be multiplied and increased a great many times."

All of which sounds pretty good, but—?

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Installation of Small Stationary Engines

By John S. Leese

When the site for the erection of a stationary internal-combustion engine of any type is under consideration, the following points must be very carefully considered:

The nature of the ground where it is proposed to place the foundation; the likelihood of annoyance to neighbors due to the noise or vibration of the engine; the possibility of damage to property due to the vibration of the engine; the allowance of sufficient room all around the engine for working on it, cleaning, etc.; the convenient location of the engine with respect to the machinery it is intended to drive; ease of conveying the heavy parts of the engine and equipment to the site; the availability of a constant and adequate water supply for cooling water or, if the supply be not reliable or adequate, the space necessary for the erection of a cooling tower or circulating tanks; location of air intake and protection of surroundings from the exhaust gases and heat.

Foundations—The first care that must be taken in the sinking of an engine foundation is with regard to the depth to which it must be carried so that it may rest on a really firm bed. For this reason "made" ground or ground that

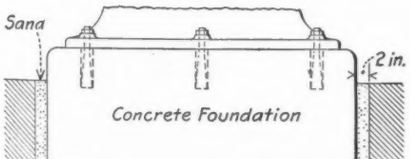


Fig. 1. "Insulated" Foundation

contains much sand, rubble or soft clay is unsuitable for the purpose. If the engine is to be erected on an upper floor or upon a raised ground floor it is, of course, necessary to make sure of the ability of the flooring to take such extra loading without liability to failure or to distortion which might damage the building. In few cases is it advisable to carry the foundations below the ground-water level, owing to the extra expense involved by doing so.

Vibration troubles—It may be found necessary, if the engine room is close to dwelling houses or offices, to mount the engine on what is sometimes known as an insulated foundation; that is, a foundation which is separated from the surrounding earth by a gap which may be filled in with waste or cocoa-nut matting or some similar material to deaden vibration. Fig. 1 illustrates this construction. It may also be necessary to bury the muffler underground so that annoyance from the exhaust shall not arise.

The insulated foundation is also advantageous for preventing damage due to constant vibration. The writer knows of a case where, owing to the location of a rather small oil engine on the first floor of an infirmary, it was necessary to deaden the vibration at all costs. This was successfully accomplished by inserting rubber pads, each 6 inches square by 2 inches thick, on each side of each of the six foundation holding-down bolts and between the engine base and the foundation, as indicated in Fig. 2.

Accessibility of Engine—The ease with which the vital parts of the engine can be got at will form, in many cases, a good criterion of the condition in which the engine will be kept. Engine attendants as a class are not particularly well remunerated, and if the engine is not easily accessible, they will not bother, in most cases, to keep it tuned up or in any better condition than is barely necessary for it to carry the load. The starting up of engines in cramped spaces is frequently not only a most difficult but also a very dangerous proceeding, especially in those cases where the operator has to "pull over" with the flywheel or by the belt. The belt should never run so near the wall that it cannot be put on or removed without difficulty, owing to lack of space. All handles, control levers, oil cups, etc., should be get-at-able without the necessity of the attendant being a contortionist. Filters and other parts which require frequent cleaning and adjustment should also be easily accessible.

Location in Respect to Drive—Complication of drive is to be avoided at all costs. If direct coupling is out of the question, a straight drive by belt, rope or chain, with the luxury of a clutch, if possible, is far preferable to spur wheels, bevel gears or oblique friction drives. Idler pulleys should be avoided if belt drive is used, unless it is impossible to get sufficient driving-surface contact on the work pulleys without them.

Delivery and Erection of Parts—In opening up new countries the transportation of heavy parts of machinery to their destination is often a matter for much tearing of hair and gnashing of teeth. It is also frequently found that even in settled countries an engine buyer has erected the engine house without any thought as to whether or not the machine will go through the door. Often a part of a wall has to be pulled down to admit a bedplate or an engine bed; in one case, where the writer was putting in an engine, he arrived to find that the demolition necessary to admit the machine was so serious that the whole wall had to be underpinned and afterward practically rebuilt. Stairways are too often a cause for trouble to the erector and underground or basement installations are extremely difficult to make. It is a not infrequent occurrence for the owner of the engine, when it has been safely put in, to prevent its future removal by erecting buildings and making alterations in the path. The installation of a new machine in an old engine room and the removal of its predecessor is frequently a hard job for the erector for this reason.

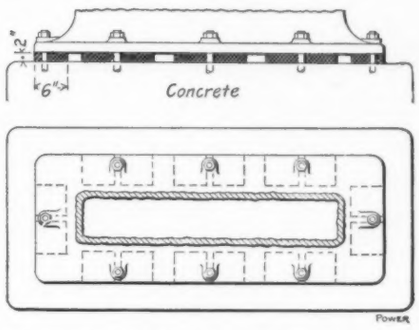


Fig. 2. Rubber Pads under Engine Bed

Water Supply—As a general rule it will be found too expensive to use city water for engine-cooling purposes. If there is no river or private supply at hand, it will be found advisable to erect a cooling tower on approved lines or else to install circulating tanks for cooling the water. These tanks should not be located in the engine room or in the

sunshine; wherever it is possible they should be put in an exposed and drafty place. Radiators are largely used in Germany for cooling the jacket water but the first cost is greatly in excess of that for tanks. The advantages of radiators are that the temperature is kept much more constant and that the space and the quantity of water required are less than with tank installations. An additional advantage in the use of radiators is that they can be used for heating the office in cold weather, being boxed off in the summer. Fig. 3 illustrates one method that has been used for shutting the radiators out from the office in hot weather and shutting them in to heat the office in cold weather. On the outside of the wall *A*, an iron door *B* is hung to run on wheels. This shuts in the radiators in cold weather. A similar door *D*, on the inside of the wall, is

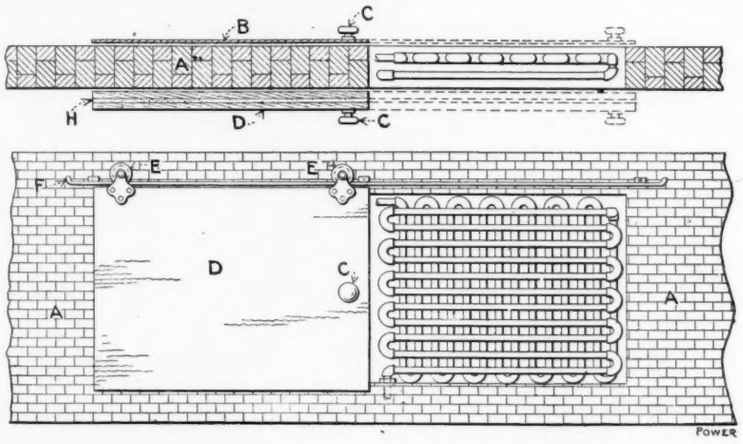


FIG. 3. ARRANGEMENT FOR SHUTTING RADIATORS EITHER INDOORS OR OUT

hung on wheels *E* running on the rail *F* and is made of two pieces of wood *G G*, with a sheet of asbestos *H*, between them. This door is closed in summer, shutting out the radiators, and opened in winter.

Air and Exhaust Pipes—The air supply should be taken in all cases from outside the building, through a filter. There is an authenticated case of a large stationary gas engine which was situated in a building, all the windows of which were shut, and was being started up for the first time. The "turning over" was effected by compressed air and great was the surprise of the beholders when two of the windows fell in with a crash. The air supply had been taken from inside the building and the sudden reduction of pressure had proved too much for the windows. While it is not suggested that an oil engine of ordinary size would cause such damage, it is an undoubted fact that most cases of rattling engine-room windows are traced to the indoor air-supply system. The advantages offered are, of course, the displacement of the contaminated air in the building by fresh air, but at best it is a drafty method of securing efficient ventilation. The air supply should be taken through a filtering screen to keep out dust and other abrasive matter.

Thick cast-iron pipes are to be preferred to wrought-iron exhaust piping because they can better withstand the corrosive action of the exhaust gases. The outlet from the exhaust box or pipe should never be in proximity to a zinc roof, as zinc is particularly liable to corrosion by the gases. Exhaust pipes should be so set that water cannot collect in bends but care must be taken that any water which may get carried along with the gases does not get blown into roof gutters or rain pipes as it would quickly corrode these. It should be needless to mention the necessity of insulating the exhaust pipe with asbestos sheet, or some other fireproof material, from any brick, masonry or wooden structures through which it may pass. Many disastrous fires have been caused by failure to observe this precaution.

Gas Engine Ignition Equipment

BY JAMES H. BEATTIE

A very large proportion of so called engine troubles are due to faults and derangements of the ignition system. This assertion has been proved over and over again by various engine men and is not questioned by those who are experienced. It is rather humiliating for an engineer who takes a pride in keeping his plant in the very best condition to have a shutdown due to a broken wire or a short-circuited igniter plug. An engine is no more reliable than its ignition system and it is very strange that manufacturers put engines out, leaving the most important of all auxiliary equipment to the discretion of the purchaser—who frequently has none. It would seem, in view of the fact that reliable ignition is the greatest factor in satisfactory operation, that the ignition system would be the object of the most scrupulous care on the part of the engine builder. Nevertheless, one finds engines, upon which the manufacturers have bestowed every care and inspected time and time again to be sure that no defective material enters into their construction, sent out on the market provided, each, with a set of six dry cells costing $1.50 and a few feet of rubber-covered wire costing 40 or 50 cents.

It has always seemed to me that the ignition system should be a part of the engine itself, not a distinct attachment. That is, it should be installed on the engine at the factory when the engine is built. Ignition dynamos and magnetos, in many cases, have been condemned when the fault lay not with the dynamo or magneto but with the way it was installed. In the first place, practical engine men have found that magnetos should in every case be positively driven by gears and not be dependent on friction drives, which are easily affected by atmospheric conditions, oil, etc. A little thought will make it apparent why the friction drive cannot be equal to a positive drive such as is furnished by a train of gears. On many engines it is difficult to keep oil off the flywheels and a very little oil will destroy the usefulness of a friction-driven magneto or dynamo. Under certain atmospheric conditions moisture will collect on the faces of the flywheels, impairing or practically eliminating the friction and making the magneto useless.

Automobile manufacturers have set a good example that manufacturers of stationary engines could well follow. They make the magneto an integral part of the engine, connecting it to the engine shaft by gears so that when the engine starts the magneto starts also. These magnetos are designed to produce current at low speed and are usually strong enough for starting the engine. Some makers of magnetos for large stationary engines provide machines that are actuated by a cam giving an oscillating movement to the armature. Such a magneto generates a strong current with which it is possible to start a good-sized engine without the aid of batteries.

The magneto should, whenever possible, be located as near the spark plug as possible, to avoid using any more wire than necessary. All wiring should be inclosed in conduits of oil- and moisture-proof construction. Engines fitted with ignition equipment of this sort have been operated for months without a single shutdown, save for normal causes. I have found that for make-and-break igniters the steel-wound cable used for carrying current in places where it is exposed to rough usage gives excellent results as ignition wire. It is not liable to be bent or broken easily—in fact, it is practically indestructible.

When several large multicylinder engines are installed in one plant it has been found best to use current from one separate dynamo rather than from individual magnetos on the engines. In such cases all wiring should be protected in conduits that will positively prevent oil and moisture from reaching the wire and which will, to a large degree, prevent mechanical injury to the wires. It is often feasible to use current from the lighting or power switchboard and in this case it is necessary to connect dead resistance between the igniters and the switchboard. Incandescent lamps are frequently used for this purpose and are connected so that they light only when the electrodes come in contact, thereby showing at a glance whether the igniters are working or not. Two engines in a small plant in which the ignition current is supplied in this way have been running night and day for six years, with very little attention. This goes to prove that where a reliable source of ignition current is supplied reliability may be had from engines under adverse conditions.

Crude Petroleum

By Frank P. Peterson

A recent editorial in Power on "The Oil Engine" suggests some remarks which may be of general interest. The statement in that editorial to the effect that no field of prophecy has ever proved more happily disappointing than that of petroleum is undoubtedly justified by the facts. Every year since the first profitable finds of oil were tapped, we have seen the beginning of the end. Those of us who have seen but little of oil operations have paid, as a rule, but little attention to statistics. We were, therefore, ready to accept as conclusive any seemingly authoritative statements predicting the end of production of crude oil in the near future.

However, let us look at some statistics on our own account. In 1859 the production of crude oil in the United States was two thousand 42-gallon barrels. In 1874, 10,927,000 barrels were produced and in 1875 the production receded to 8,789,000 barrels. Had the statistics then been studied, they would, no doubt, have seemed much more discouraging as to the probable life of the industry than they now appear.

In 1903 our production reached 100,463,000 barrels and the years since that date have shown a remarkably rapid increase of production. There is one recession only, for the year of 1906, when the production dropped from 134,717,000 to 126,494,000 barrels. In 1907 there was an increase of 31 per cent. over the preceding year and 1910 showed nearly 19 per cent. over 1909.

World production has, in a measure, followed that of the United States, showing a healthy and almost continuous advance, with one recession in 1906, due, no doubt, to our own heavy recession for that year. Galicia, Japan, Germany and Peru show recessions for 1910 as against 1909, but the total world production shows an advance for 1910 over 1909 of 11 per cent. The world production for 1903 was 194,910,643 barrels and for 1910 it was 335,388,368 barrels.

Reduced to a power equivalent in a good Diesel engine, consider the value of this oil. At 6 pounds per gallon and 19,000 heat units per pound, each barrel of 42 gallons should produce 600 horsepower-hours and the power equivalent of the 1910 world production would make a string of figures too long to read with any degree of comfort—over two hundred billion—the equivalent of 22,970,000 horsepower 24 hours a day every day in the year.

But little need be said of the advantages of oil as fuel for power; they are pretty well recognized, and the perfection of motors that can utilize it with a great degree of satisfaction only tends to hurry the industry to a point which will encourage the much needed economy in the production of petroleum that has never yet been practised to the extent that it should be.

And from a consideration of the crude and its possibilities in the field of power generation we must not pass without noticing the refined gasolene products. The modern development of the lightweight, high-speed gasolene motor has caused such an increase in the demand for this portion of the crude oil that not much of it is likely to be consumed in the heavier lines of power development. Indeed the farmer and the blacksmith may soon have to turn to the cheaper crude residue which, after being stripped of its gasolene, is quite satisfactory in an engine of the Diesel type.

LETTERS

Producer Capacity When Operating on Lignite

In a recent number of Power an inquirer asked how much power a No. 7 Wood gas producer should supply in gas made from Texas lignite; the answer was that with lignite of 8000 B.t.u. it would supply an engine of 300 horsepower. It seems to me that this is much too high, because I know of an installation where a No. 7 producer fell so far short of supplying a 300-horsepower vertical single-acting engine that a No. 8 producer was added. No test has been made since the second producer was installed, so I do not know whether both of them have to be worked at full capacity to supply the engine or not. But I think it impractical to take care of a 300-horsepower engine with one No. 7 Wood producer using Texas lignite.

George A. Blucher.

Corpus Christi, Tex.

There are lignites and lignites. Upon investigating the case cited by Mr. Blücher we learned that the lignite used in the plant to which he refers was much below the average quality, judged by gas-producer requirements. It is quite obvious that with lignite containing, say, 6000 heat units per pound, a producer will not supply as large an engine as with lignite of higher heat value, but the grade used in the plant mentioned must have been worse than any we know of, in order to make it necessary to run a No. 7 and a No. 8 producer for a 300-horsepower engine.

The figures given in our answer, we learn, were a little too favorable. With ordinary Texas lignite of about 7500 B.t.u. per pound, the No. 7 producer should supply gas enough to run a 250-horsepower engine of good efficiency at rated load, provided the ash is not such as to cause abnormal clinkering.—Editor.

Unusual Packing Ring Reinforcement

A three-cylinder vertical producer-gas engine had been giving considerable trouble, passing oil by the rings of two pistons and depositing carbon in the cylinders. The cylinders had become worn so that the pistons had approximately 0.04 and 0.065 inch clearance (the engine is about six years old). I took out both pistons and cleaned them and the rings thoroughly. Then I put one turn of ¼-inch round braided fiber packing in each compression-ring groove of the one piston and slipped the rings on over it. For the other one, in addition to the packing, I got some straight strips of spring steel $\frac{1}{8} \times \frac{3}{8}$ inch and long enough to bring the ends within ½ inch of meeting when the strip was bent into the ring groove over the packing; about 4 inches of the ends were bent to form a circle when the ends were brought together. I put one strip in each compression-ring groove over the round packing and held the ends together while I slipped the rings in place. Both pistons were given a liberal dose of graphite and oil and put into commission. That was three months ago and we have not found a spoonful of carbon in either cylinder since and the pistons do not slap as before. The engine runs 16 hours a day except Sundays. Eventually both cylinders will have to be rebored and new pistons fitted, but we could not arrange to do that now, therefore this experiment.

J. W. Fries.

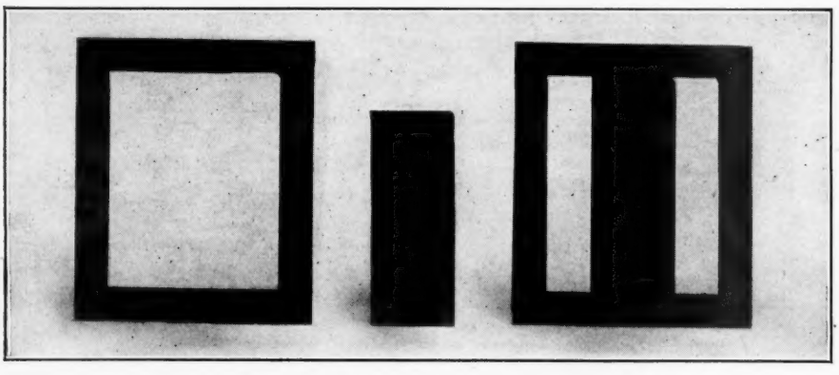
Middleboro, Mass.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

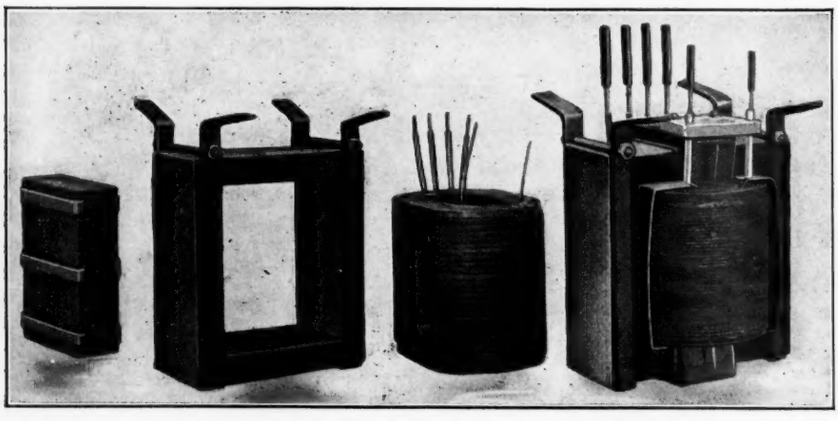
The Remek Transformer

The general design and construction of transformers for ordinary service were reduced to a basis of standard uniformity several years ago, but there are always details to which the ingenuity and skill of the designer may be profitably applied. The Remek transformer built by the Crocker-Wheeler Company is an excellent illustration of the truth of this assertion. It is of the well known shell type, in which the windings are arranged in a single group surrounding the main core of the magnetic circuit and being surrounded by the "return" or yoke structure. In that respect it is precisely like all other shell-type transformers, but there are several detail features of interest.



FIGS. 1, 2 AND 3. REMEK TRANSFORMER CORE PLATES

A yoke plate and the corresponding core plate are punched from sheet steel by one stroke of the press, in order to make sure of an accurate joint between the ends of the core plates and the abutting edges of the yoke plates. This expedient is said to be so successful that the insulating compound which is forced into all openings of the complete transformer under a pressure of 60 pounds per square inch does not penetrate into the joints between the core and the yoke. Fig. 1 shows a yoke plate, Fig. 2 a core plate and Fig. 3 the two together in "working" position.



FIGS. 4, 5, 6 AND 7. REMEK TRANSFORMER PARTS

The core plates are assembled under pressure and held together by clamps which do not surround the core and therefore do not form closed secondary circuits for the flow of induced currents. This construction is illustrated by Fig. 4. The yoke plates are assembled over the ends of the completed core, then subjected to pressure and held together by clamps which do not surround the magnetic circuit; Fig. 5 shows an assembled yoke without the core and illustrates how these retaining clamps are disposed.

Fig. 6 shows a complete group of coils standing on end in the position which it occupies on the core and in Fig. 7 may be seen the heavy insulating sheets between the outer surfaces of the winding and the inner faces of the yoke; also the supplementary clamps at the top and bottom of the structure for holding the core in place in the yoke. At both ends of the windings the coils are spread apart to permit circulation of oil between the sections; these end portions project beyond the mass of the yoke, as shown in Fig. 7. Fig. 8 illustrates the spreading of the coils to provide oil ducts. In this particular case the low-tension winding was made up of copper "ribbon." This was wound on the forming bobbin first and the high-tension coils were wound on top of it, suitable insulation being applied to the outside of the first winding, of course, before the outer one was started.

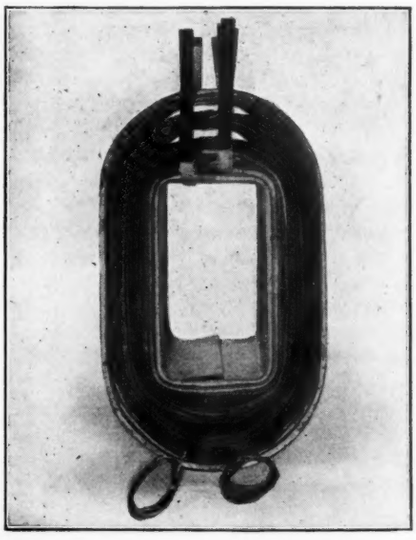


FIG. 8. COMPLETE WINDINGS

The core and yoke are made up of silicon steel which is said to be free from "ageing" and the absence of lap joints in the magnetic circuits is claimed to prevent eddy currents in the steel.

The insulation is also claimed to be unusually efficacious and durable. After the coils are wound and put in place, they are cleared of moisture and air by the usual vacuum process; then the crevices are all filled and the surfaces covered by a compound which is insoluble in oil or water, the compound being applied at 60 pounds pressure per square inch.

The Electrical Section of the Bureau of Mines

The United States Bureau of Mines, which is doing such valuable work in the investigation of methods and apparatus for the utilization of fuels, is also doing excellent work in the way of investigating electrical apparatus used in mining and the conditions and manner of use. A distinct Electrical Section of the bureau was organized about two years ago to make these investigations and to collect data which would be of assistance to those State officials who have charge of the regulation and inspection of mines and to all who use or manufacture electrical mining equipment. The section is part of the mining-experiment station of the bureau at Pittsburg, Penn.

Among the purposes of the section are the ascertainment of the causes of accidents from the use of electricity in mines and the suggestion of means for the prevention of such accidents; making tests of the safety of electrical equipment under conditions most conducive to disaster, and making such tests of a general nature as bear upon the safety of electricity in mines, accidents attributed to electrical causes, etc.

Electricity is used underground in mines for haulage, lighting, driving pumps, fans, drills, coal-cutting machines and hoists, for detonating explosives and for signaling.

Both direct current and alternating current are used, the former much more extensively than the latter. Direct current is distributed at potentials up to 600 volts wherever power is used. Alternating current is distributed at over 2000 volts and is usually carried only a short distance underground to serve high-voltage motors or transformers operating motor-generator sets or rotary converters.

Electric haulage is operated principally from trolley wires at 250 or 500 volts. The trolley wire is necessarily bare, and in low coal is dangerously near the heads of persons in the same entry with it. Lighting circuits are often connected between the trolley wire and earth, with the lamps in series. Stationary motors are often connected between the trolley wire and earth. Machine wires are frequently bare up to the point of connection with the trailing cables.

Explosives are detonated from batteries (storage or primary), from magneto generators (frequently referred to as batteries), from power circuits and from separate generators used only for detonating. Signals, which include lights, bells and telephones, are operated principally from primary batteries.

Conditions of Operation

Underground equipment is exposed to falls of roof, coal and rock that are sufficient to wreck installations of the best character. The acid waters and the dampness in mines make the insulation problem difficult.

The fact that the need of electric service at many points underground is only temporary, limits economical investment in equipment. The temptation to install electrical equipment in coal mines in a temporary and improper manner is increased by the fact that coal, especially dry coal, is not a good conductor of electricity, and wires may sometimes come in contact with the coal without causing trouble. A machine wire supported upon wooden pegs driven into the coal may never give trouble, and it would be hard to convince a man whose only experience had been with such installations that to thus support a wire is not good practice.

In this connection it is probable that electrical practice in mines would be generally improved if more of the mine electricians were familiar with the best installation methods.

The problem of safeguarding life is rendered still more difficult by the fact that many of the underground workers do not appreciate the dangerous character of electricity and ignore the rules made for their protection.

The three principal dangers connected with the use of electrical equipment in mines are the danger from electric shock, the danger from explosions caused by electricity and the danger from fire started by electricity.

The chief sources of danger from shock are the trolley wire and other bare conductors. Another source is ungrounded equipment that has become charged with electricity through defective insulation or otherwise.

The danger from electrical explosions arises from the occurrence of sparks and arcs in inflammable gas or dust. Sparks of sufficient size to ignite gas may be produced when a motor is started rapidly or operated under heavy load, when a circuit carrying current is opened or when a circuit becomes grounded. A much larger spark is required to ignite bituminous coal dust, but such dust might be ignited by the opening of a circuit carrying a large current or by flashes produced by heavy short-circuits. The fall of a trolley wire might produce both of these conditions.

The danger from fire arises from grounds to coal or in the vicinity of inflammable material, from the flashing of motors under the latter condition, from short-circuits and the burning off of wires carrying heavy currents.

Besides the above mentioned dangers, the handling of explosives in the vicinity of electricity and the detonation of them by electric means give rise to others.

Safeguarding the Use of Electricity

The practical solution of the problem of safeguarding the use of electricity in mines will require the adoption of protective measures and of devices that are simple, rugged, "fool proof" and as inexpensive as possible. At the same time, both measures and devices must be entirely effective or they will become menaces.

Although it will be necessary to investigate many possible causes of electrical dangers, some are already well known, and the desirability of protection against them is apparent.

There is a field for devices for reducing the danger of shock from the trolley wire and for devices for preventing the ignition of gas by motors, switches and other circuit-opening aparatus. There is a field for an acid-proof material for insulating wires and cables and there is room for improvement in the methods of installing electrical equipment underground.

Equipment of the Electrical Section

Direct current is available for testing purposes in any voltage up to 750 volts, and alternating current up to 2000 volts for power and up to 30,000 volts for high-potential tests.

The laboratory is provided with a 6-panel switchboard for the control of transformers, generators and circuits; a complete equipment of alternating-current and direct-current voltmeters and ammeters; an outfit for measuring insulation resistance up to 80,000 megohms; a 5-kilowatt high-potential testing transformer, the voltage of which can be gradually varied up to 30,000 volts; a Wheatstone bridge, rheostats and miscellaneous tools and supplies.

There are two galleries for testing electrical equipment in the presence of gas. The smaller of these is installed in the laboratory; it consists of a boiler-iron box provided with connections for gas and air, heavy plate-glass observation windows and openings for relieving the pressure caused by an explosion. A small motor-driven centrifugal fan is used to mix the gas and air and to circulate them through the gallery. Means are provided for predetermining the percentage of gas in the mixtures used. Tests of electric sparks and of incandescent lamps and small apparatus are made in this gallery.

The larger testing gallery is a tube designed to represent a short section of a mine entry. It is erected outside the laboratory and consists of a cylindrical shell of boiler iron 30 feet long and 10

feet in diameter, laid horizontally upon a concrete bed and partly filled with concrete to form a floor upon which apparatus can be set up for test. At 7½ feet from either end the cylinder can be stopped off with diaphragms of heavy paper, which relieve the pressure from explosions before it becomes dangerously heavy. After the diaphragms are in place the gallery can be entered through a manhole cut in the side of the shell between the heads. Heavy glass windows are set in the sides of the gallery.

A large motor-driven centrifugal fan mixes and circulates the gas and air and a special device has been developed to indicate the percentage of gas in the mixtures. Tests of explosion-proof motors, explosion-proof switches and other large apparatus are made in this gallery.

A gallery or testing tube for investigating the ignition of coal dust by electricity is now being designed and will be constructed shortly. This gallery will be similar in most respects to those already described, but will differ in a few details.

The electrical section of the bureau has made a few preliminary investigations, the most important of which are an investigation as to the danger of gas ignition by the indicators of inclosed fuses, and an investigation as to the danger of gas ignition by incandescent lamps when broken in gaseous atmospheres. The former is reported in detail in a pamphlet designated Technical Paper No. 4, by H. H. Clark, to which we are indebted for the foregoing information; the latter is being continued, and a final report will be made later.

Although the function of the section is to investigate and test rather than to develop, facts that will be of value to those designing equipment are continually being learned in the process of testing and are always at the disposal of interested persons.

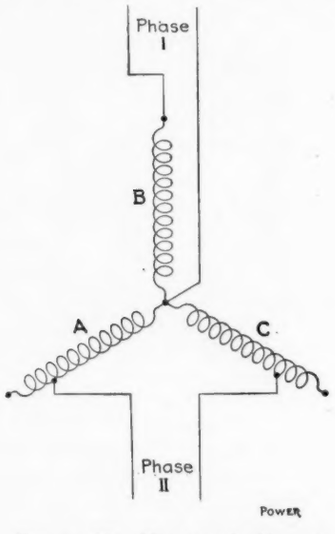


FIG. 1. MR. MALCOLM'S METHOD

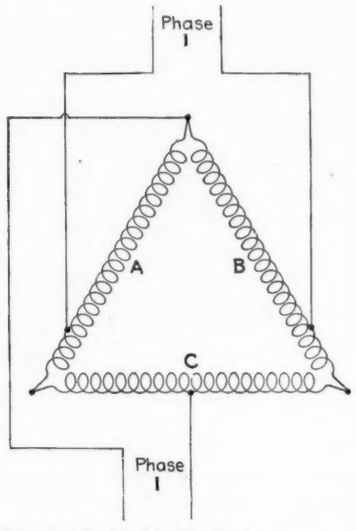


FIG. 2. S. H. HARVEY'S METHOD

CORRESPONDENCE

Two Phase Three Phase Transformer Connections

Referring to the transformer connections proposed in the July 4 number by S. H. Harvey for connecting a two-phase and a three-phase circuit, permit me to point out that his method would entail a serious flow of wattless currents and an overlapping of the two-phase currents which would cause bad regulation and necessitate the use of larger transformers than would otherwise be required. A much better method would be to connect the windings up Y-fashion, as indicated by Fig. 1 herewith. This diagram shows only one set of transformer windings; the other set would be connected to the three-phase circuit in the usual way.

This arrangement has the slight disadvantage of not utilizing all of the windings *A* and *C*, but that is better than to have useless currents circulating in them and overlapping the currents of the two phases. Phase I is supplied exclusively by the transformer *B* and Phase II by the transformers *A* and *C* in series. In Mr. Harvey's proposed arrangement, shown in Fig. 2, Phase I is supplied by the transformer *C* partly opposed by the short ends of *A* and *B*, and by the long ends of *A* and *B* in series; Phase II is supplied conglomerately by all three windings, of which *C*, however, acts differentially. Therefore the currents of the two phases are superimposed in the windings and produced by complex resultant electromotive forces the unbalancing of which must set up wattless local currents. The arrangement in Fig. 1 is free from these disadvantages.

When all is said and done, however, the T-connection originated by Charles F. Scott is by far the best method.

GEORGE W. MALCOLM.

Brooklyn, N. Y.

The use of three similar transformers for connecting three-phase and two-phase circuits as described by S. H. Harvey in the July 4 number is open to the disadvantages that there is heavier wattless current flow and the regulation is poorer than with the Scott connection. The excessive wattless current necessitates the use of larger transformers; the cost, therefore, will be greater.

A. L. HARVEY.

Pittsburg, Penn.

Cutting Out Dynamos from Parallel Service

In the issue of June 27, on the page of "Inquiries of General Interest," a correspondent signing himself "W. H. L." asks for an explanation of bad speed regulation of one of two engines driving dynamos in parallel. The correspondent states that when transferring the load from the large to the small generator the voltage drops momentarily from 125 to about 75 or 80 volts, and your statement that the cause of this trouble is a sticky governor on the small engine is undoubtedly correct.

It may be of interest to this and other readers to point out that it is not a good plan to throw a considerable load on a machine all at once. The large machine in the case cited was stated to be twice the size of the small one; therefore, if both were carrying the same proportional load just before the large generator was cut out, the small one must have had its load suddenly increased from one-third to full load. With many generators, especially of the older types, this will cause sparking at the brushes and may require that they be shifted. A safer way would be to slowly weaken the field of the large generator, at the same time strengthening that of the small one so that the voltage would remain unchanged. This will require a few moments more for making the change but that would be unimportant and would prevent any drop in voltage even if the governor of the engine did not act quickly enough and at the same time would prevent any trouble from sparking.

I do not mean that the governor should not be attended to at once, but merely that if the generator were carefully cut out there would be no drop in voltage even if the engine were not governing correctly. The proper plan is, of course, to have all machinery in as perfect condition as possible so that it will act properly under all conditions, but those conditions should not be made any more severe than necessary.

G. H. MCKELWAY.

Brooklyn, N. Y.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Receiver Presssure Spring Rods

Some few years ago in a power plant a new cross-compound engine, 30 and 60 by 48 inches, running at 80 revolutions per minute with 140 pounds steam pressure was operated for some months non-condensing.

The engine ran smoothly at first, but after the condenser was connected it pounded badly, because of the position of the exhaust eccentric.

At this stage an experiment was tried with the receiver pressure to reduce the pounding in the low-pressure cylinder. The receiver pressure was started from 18 pounds downward and the pounding seemed to grow less with each change, but it would return a few moments later to its usual loudness. Finally getting the pressure down to about 7 pounds and while waiting to see if it was stationary, the assistant shouted that something was wrong.

The low-pressure piston rod, 6 inches in diameter, was riding on the rod-packing case and smoking. I hurried to the governor and raised the receiver pressure, whereupon the rod came back into its central position and ran all right for the remainder of the day.

The matter was reported to my superiors, but as no satisfactory solution was given it was finally dropped. To my mind the low receiver pressure was the cause of the trouble.

A second instance occurred about a year later on a cross-compound 16 and 32 by 42-inch engine running at 120 revolutions per minute with 120 pounds steam pressure. The low-pressure piston rod was 4½ inches in diameter. Just after one o'clock the load started to come on. This engine had not been running over 10 minutes when the assistant called to me to hurry to the low-pressure side as something was wrong.

The rod was riding on the packing case and smoking as in the first instance, and orders were given to shut down. After the load was off and before the engine was stopped the rod came up clear and central. While the engine was cut in, the receiver pressure was about 2 pounds, whereas from 6 to 8 pounds was usually carried.

The attention of the chief engineer was called to the fact that the piston rod had raised clear off the packing case after the steam had been shut off, and that the receiver pressure was low at the time of the trouble. As he had been previously told about the first instance he was persuaded to try the engine again with the normal receiver pressure. Everything was found to be all right and the engine ran the rest of the day.

But what made the rod spring down so that in both cases it rode on the packing case and scored it?

Almost any engine can be loaded heavily enough to bring it to a dead stop without springing of the rods, but in these instances no reduction of speed was noticeable.

In many engines the low-pressure piston rod is larger than the high-pressure, although it is usual for it to carry no more load than the high-pressure, and any springing would show that considerable resistance was being exerted.

L. M. GLODELL.

New Haven, Conn.

Smoke Preventer

How to avoid smoke coming out of the chimney is one of the troubles of some engineers. Quite a few fines have been paid because of violation of the smoke nuisance and recently one company was fined $2400.

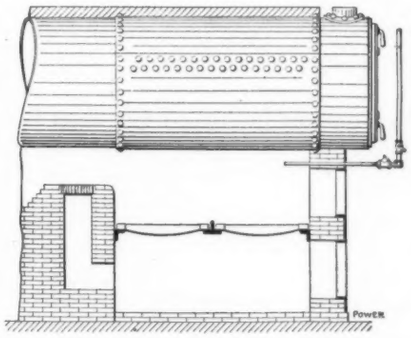


FIG. 1. ELEVATION OF FURNACE AND STEAM JET

The accompanying illustrations show a form of smoke consumer that I am using with excellent results. There are four 2-inch pipes, Fig. 1, 14 inches long, extending through the boiler front to the inner side of the brickwork. Inside of each is a ¼-inch pipe which extends three-fourths through the 2-inch pipe. Each is fitted with a cap having three 1/16-inch holes which act as steam jets and draw in the air for a period of two minutes after each firing. The jet is then shut off by means of the valve shown at the right. There are also covers which drop down by turning the crank at the left after the jet has been shut off to prevent cold air from drawing in over the fire.

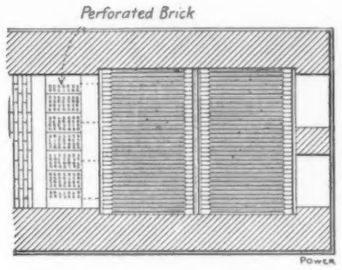


FIG. 2. PLAN OF FURNACE

Fig. 2 shows the bridgewall of the boiler. It has a row of perforated brick on top that are set over a hollow section and air ducts are provided under the grates, causing air to mix with the combustible gases. Although this method has a tendency to cool down the furnace temperature and increase the coal bill, it almost entirely prevents the formation of smoke. With a coal consumption of 12 tons per day, under three 200-horsepower boilers, one can scarcely tell when the furnaces have been coaled.

A. C. WALDRON.

Revere, Mass.

Clogged Condenser Gage Pipe

In the plant where I was engineer a few years ago there was an independent air pump and jet condenser used to condense the exhaust steam from a tandem-compound engine. On starting up one morning, after several days' shutdown, the vacuum gage showed but 16 inches of vacuum. There was about a 20-foot lift of the injection water, and as the pump was running normally and the condenser was cool, it showed that it was getting all the water necessary to condense the exhaust steam.

It was evident that the trouble was not in the pump or in the condenser.

I disconnected the union near the vac-

uum gage and when I put my finger on the end of the pipe I knew I had discovered the trouble; there was no suction to speak of in the ¼-inch brass gage pipe. I removed the pipe and found that two cast-iron elbows, which were under the floor, had been substituted for brass ones. The cast-iron elbows were plugged almost solid with iron rust. After putting in new brass elbows the gage showed 26 inches of vacuum, and no further trouble was experienced.

A. LAMARINE.

New Bedford, Mass.

Lifting Water in Boilers

I believe that the average boiler explosion, caused by cutting in a boiler when the pressure is above the line pressure, is due to the rapid evaporation of the water and not water hammer.

A boiler on the line has its water in circulation and only a part of the water is at or very near the right temperature to flash into steam.

A burst steam pipe would suddenly lower the pressure and cause more water to flash into steam, but the circulation would not be upset for some time.

As the temperature ranges from the flashing point at the pressure carried down to the temperature of the entering feed water, all the water could not flash into steam at once, but would produce water hammer if it did not follow in the path of the downward circulation.

When a boiler is being fired prior to cutting in on the line, the fires have been burning more or less slowly, the water circulation is practically dead and the temperature of the water has been raised against a steady, increasing pressure.

The greater portion of the water in the boiler is at the same temperature and just about at the flashing point.

Now open the stop valve suddenly to a lower pressure. All the water which is at the temperature range between the original pressure and that to which the pressure falls will flush into steam.

Because there is no circulation in the boiler, the rise of steam bubbles will cause the water to lift and relieve the water in the lower parts of its weight and release more steam.

The pressure and temperature rise quickly and the boiler shell, not having time to adjust itself to the new condition, lets go.

If the water lifted were projected against the head or allowed to fall back as solid water, it would wreck the boiler, but the density is so reduced by the steam bubbles that with the exception of very long vertical boilers, the shock of the striking water would not wreck the boiler if it stood the sudden rise in pressure.

By opening the stop valve to a cold boiler or one under a pressure very much below the line pressure a bad water hammer might be started that could wreck the boiler.

I think that flattening out of sheets and the distorted appearance of an exploded boiler is due to the reaction or kick of suddenly fractured metal, the same as a broken chain or wire rope. I cannot see how water-hammer action similar to that taking place in a header or pipe can occur in a boiler with a higher pressure.

In the case of a bad pipe water hammer there is a solid plug of water with a vacuum before it and a greater or less distance through which the plug travels, acting as a pump plunger to a certain extent.

Evaporators such as are used on board ship, when connected direct to the main condensers, will foam badly if the discharge valve is not kept partly closed. All the water appears to be at the top.

I have never been able to detect any shock when the foaming was stopped either by shutting off the live steam or choking the discharge valve. I do not mean that water lifting does not take place or that it is not dangerous to a certain extent, but I believe that the danger is more from the shifting of weight than by the impact of water against the head or bottom.

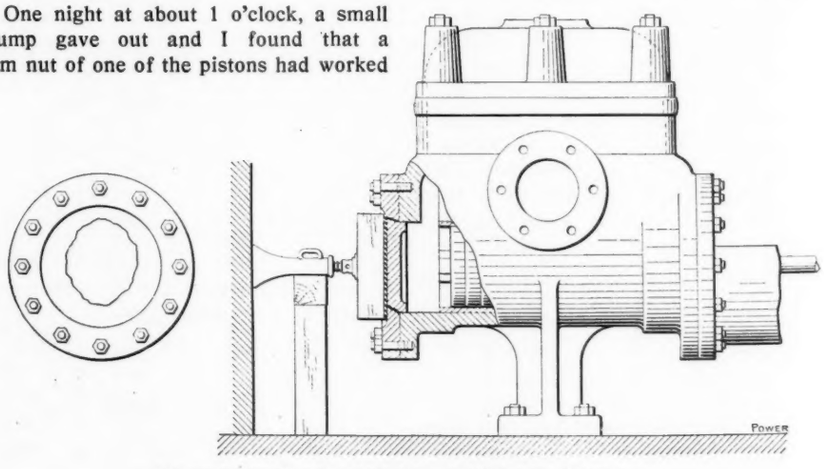
In cutting a boiler in on the line, I always free the boiler of air and shortly before the pressure is the same as on the line, the feed valve is opened part way and kept open. This starts the water to circulating and the boiler is in condition to go to work.

C. J. HARDEN.

Chicago, Ill.

Running a Pump with Broken Cylinder Head

One night at about 1 o'clock, a small pump gave out and I found that a jam nut of one of the pistons had worked loose and knocked a section out of the cylinder head.



METHOD OF HOLDING CYLINDER HEAD IN PLACE

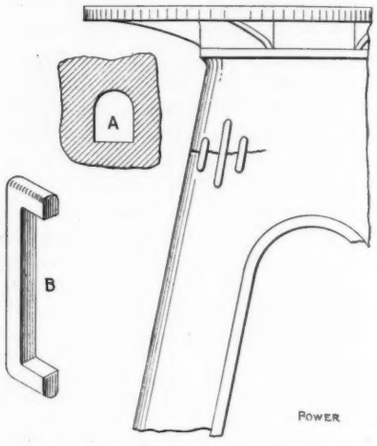
I tightened up the jam nut and replaced the broken head, putting a piece of sheet packing over the broken place and a piece of board over the packing. A jack screw was placed against a coal bunker and tightened up, which stopped the leak sufficiently to permit the pump to run until another cylinder head was obtained.

JOHN D. MEYER.

New York City.

Repaired Engine Frame

The illustration shows a repair job that was successful. The fracture was in a guide column under the intermediate cylinder of a triple-expansion engine. The crack extended around the back and two sides. Holes were made in the frame by drilling a 1¼-inch hole and two ⅝-inch holes below, and then chipped to the shape shown at *A* with a cold chisel. The clamps were made of 1¼x2-inch bar steel, in the shape shown at *B*. The short clamps were about 8 inches long, and the longer ones were 15 inches. The clamps were put into the boiler furnaces and placed in the holes red hot and the contraction closed the crack.



CLAMP APPLIED TO CRACKED FRAME

W. E. DEAN.

Superior, Wis.

Oiling Kinks

When oiling machinery of any kind, especially an engine, it is annoying to stick the spout of an oil can into the oil hole and have it caught because it was run in too far. By soldering a piece of tin or other metal or even running

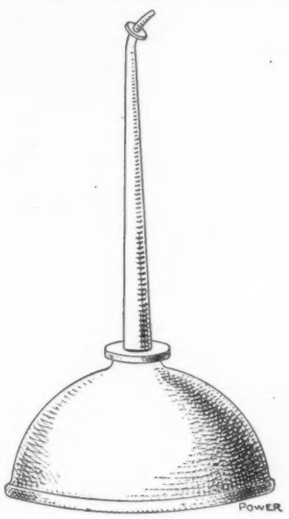


FIG. 1. SHOWING RING OF SOLDER ON SPOUT

a heavy ring of solder around the spout of the oil can a desired distance from the end of the spout, as shown in Fig. 1, the end of the spout will be prevented from entering the hole too far.

Another annoying thing about oiling is the manner in which the oil is applied to the wristplate bracket pin, on close-coupled high-speed and even on medium-speed Corliss engines. This pin is very hard to oil, and the oiling must

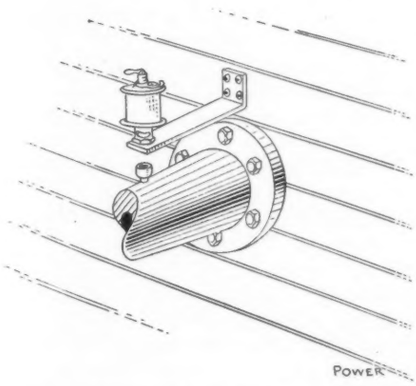


FIG. 2. SHOWING OIL WIPER ATTACHED

either be intermittent, as the oiler happens to think, and squirts oil on, or a glass or other kind of oil cup is fastened directly to the wristplate, which arrangement does not give good oil regulation.

I have made a change that permits fine oil regulation by screwing a wiper into the hole where the oil cup was. Then two holes were drilled in the lagging of the cylinder and tapped out for small cap screws which held a piece of ⅛-inch iron, bent to the suitable angle. The oil cup was fastened to the iron arm and as the wiper moved back and forth it received sufficient oil to lubricate the wristplate bearing.

R. S. WILHELM.

Indianapolis, Ind.

Preventing Steam Turbines from Racing

In a certain steam plant there are three 1500- and one 750-kilowatt Parsons turbines. These turbines were inclined to run greatly in excess of their normal speed when operating under little or no load, due partly to the lack of lubrication and partly to the admission of too much steam beneath the steam piston of the primary valve.

Originally the oil was admitted through

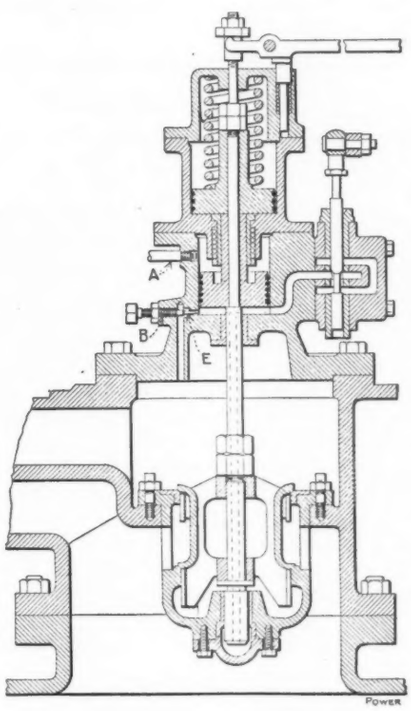


FIG. 1. SECTION THROUGH CONTROLLING VALVE

a ½-inch pipe connection *A*, Fig. 1, and was exhausted with the steam which leaked around the piston to the atmosphere by means of a ½-inch pipe connection, on the same plane as the lubricator connection, but 90 degrees farther around and not shown by the illustration.

After changing, the lubricator was attached to the ½-inch pipe connection on the tee-shaped fitting *C*, Fig. 2; and this fitting was connected where the needle valve formerly was, or at *B*, Fig. 1. After tapping a ⅝-inch hole for the ¾-inch pipe the needle valve *E* was lengthened and extended through this fitting and made contact with its seat as formerly.

The change has, therefore, no effect on the adjustment of the needle valve. But as the steam must pass through this needle valve to operate the piston and feed the oil into the steam by means of the tee-shaped fitting, the steam becomes thoroughly saturated with the oil before it has reached the piston, thereby insuring perfect lubrication.

Referring to Fig. 1, it will be seen that a stem passes through the valve which extends down into a bronze bushing or guide. In order to relieve the recess below the end of the valve stem of any pressure which may be created,

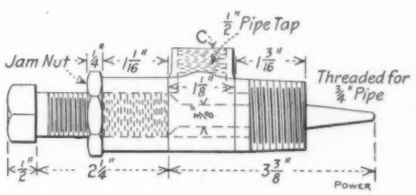


FIG. 2. DETAILS OF TEE FITTING

a hole has been drilled through the center of the stem.

This allows the steam which leaks around this bushing to exhaust into the cylinder just beneath the piston. After being in service for some time this bushing becomes worn. The amount of steam which passes around this and is exhausted beneath the piston is so great that the primary valve is not able to seat, and with little or no load the turbine will speed up.

This may be readily overcome by tapping out the hole in the end of the valve stem and screwing in a plug. Then file three or four grooves in the bronze bushing which will allow the pressure to equalize beneath the stem and thus it will in no way interfere with the proper working of the valve.

A small hole, about 3/32 inch, may be drilled in the cap which holds the bronze bushing in place, which will drain into the turbine any water which may collect below the stem. Although this hole will permit steam to enter the turbine even though the valve be closed, the amount will be so small that it can have no effect on the operation of the turbine.

BURTUS VINNEDGE.

Hamilton, O.

A certain steam pipe vibrated so much that the engineer found it necessary to drive wedges between it and the wall. It was decided that the vibration was in phase with some of the reciprocating parts of the engine. To stop it heavy cast-iron weights were hung beside the pipe and bolted to it at the flanges by heavy iron straps. The weights did the work.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Poor Draft

In the July 4 issue, Mr. Cotton says he has poor draft. I think the fault is because the distance between the back wall and boiler is only 15 inches—it should be 24—and between the flue doors and boilers the distance is 17 inches which should be 20.

I think if Mr. Cotton would place a ¾-inch steam pipe at the bottom of his upright stack, putting an ell and a short piece of pipe so that a small amount of steam would flow upward, he would get all the draft he wanted.

Care should be used not to make it too strong as it will cause the fire to clinker.

L. B. Scott.

Clarksburg, W. Va.

L. P. Cotton states that he has poor draft. The size of his stack is as given in ordinary installations and the smoke connection is nearly correct, although 16x67 inches would be better. The distance between the boiler head and rear wall should be 30 inches instead of 15. If there are high buildings or trees near the stack it may be necessary to add to the hight.

Mr. Cotton should make and install a draft gage so as to tell how much draft there is. A gage was described recently in this paper. If his firm will install a blower (of which there are many types) he can get all the steam he needs. A blower will soon pay for itself in the fuel saved from being poked into the ash pan. Any kind of fuel must burn if the draft is forced.

Roy V. Howard.

Tacoma, Wash.

What Causes the Pipe to Wear

In the June 13 issue of Power, S. Kirlin wants to know why the top side of the horizontal discharge pipe through which water, mud and sand is pumped, is worn more than the bottom.

Mr. Kirlin will find an answer to his question, if he will stop to think that in any mixture of different-sized particles, either solid or part solid and part liquid, when violently agitated or disturbed, the tendency is for the larger particles to be held upward, while the finest particle will work toward the lowest point. In a bucket filled with water and a few handfuls of sand and gravel thrown into it, when swiftly stirred, the largest particles will be felt the highest on the stirring stick. Thus the friction of the coarse particles against the top of the pipe rapidly wears it away, while the bottom of the pipe gets practically no friction.

L. M. Johnson.

Glenfield, Penn.

Boiler Management

In the June 13 number of Power I noticed Mr. McGahey's article, "Deterioration of Boilers," in which he speaks of steel becoming brittle from long use. Is it possible to renew the life of the metal occasionally by any known method?

Lately I was talking with an engineer who recommended that a slow fire be built under a dry boiler to anneal the metal and stop its crystallization. The flues are to be rerolled while the boiler is warm, and in no instance must the boiler be heated red hot. Has any reader ever tried or made a practice of this method of retreating boilers to give "a new lease of life"?

The engineer above referred to had just taken charge of the plant and I was asking about some blowoff trouble which had happened a few days before, whereupon he invited me around to see the arrangement of this very necessary fixture.

The naked nipple was screwed into the boiler and was so very short that the piece of pipe extending out through the wall of the furnace was in the hottest flame. Because of this it became so "frail" that it gave way under the strain.

The engineer was very anxious for Sunday to come so that he might put in a longer nipple, incase it and drop the extension pipe below the fire line.

It is a sad state of affairs that an engineer, after discovering and having trouble with a thing of this kind, is compelled to wait until Sunday to correct it, while every moment of its operation is practically as dangerous as it would be to continue it for a greater time.

Who is to blame that the plant owner is not more informed regarding dangers existing in his plant, if he is ignorant of engineering? Should an engineer be forced to take questionable orders from the boss who is ignorant along this line?

The plant owner should always be well informed to appreciate a careful engineer's findings and recommendations in the building of a steam or other kind of plant.

There are a few small plants where gross ignorance is displayed by both parties.

This state of affairs, I am glad to see, is improving every day, and I see no reason why anyone should be ignorant of fundamental principles, since the opportunity for learning is greater than ever before.

Lloyd V. Beets.

Nashville, Tenn.

Boiler Design

In the issue of June 27, J. E. Terman expresses his disbelief in some of the statements made by me in my recent article on the above subject. Of course, I expected disagreements, but I shall not enter into a controversy concerning them.

If Mr. Terman can enjoy peace of mind in contemplating a boiler with its ends tied together by means of a flexible connection in transverse strain he is fortunate. The fact that such boilers have not exploded is not a measure of their nearness to explosion.

Concerning the saw-tooth butt joint, I read many years ago, when I was a member of the Institution of Mechanical Engineers of England, the report to which Mr. Terman refers. In my opinion it is far better to make the butt straps of a boiler narrow and correct the weakness which Mr. Terman suggests by making the butt straps thick. It is important that the inside butt straps, which in general are not calked, should be narrow and thick for reasons that I have before explained.

Concerning a coned plate, many have been made and have been used in locomotive boilers for 75 years in tens of thousands of cases, and are being made now, and it is hard to believe that there is the least difficulty in making them.

Readers may be interested to know that the boilers of the great steamships "Olympic" and "Titanic" have butt straps with the very wide pitches recommended by me before I adopted the saw-tooth form, and, of course, many of

them know that the latter form has been used by the North German Lloyd line for 15 years or more.

F. W. DEAN.

Boston, Mass.

Mr. Terman criticizes to a certain extent Mr. Dean's article in the May 16 issue. I heartily agree with Mr. Terman that the attack on the Manning boiler is entirely unwarranted. The Dean vertical boiler, while strong and rugged, is of small capacity compared to the Manning boiler of the same size or of equal cost, largely owing to the gallery which is left between the tubes and the shell; this greatly increases the water space but very largely reduces the heating surface; therefore, for the same capacity the diameter of the boiler must be made very much greater.

Doubtless the reason for the comparatively small number of tubes is the fact that the firebox is of smaller diameter than the shell, and it is of no avail to use an amount of heating surface which is larger than that for which the grate surface can economically supply heat. In the Manning boiler the firebox is enlarged or the diameter of the shell is decreased. The result is that the thickness of the head and of the shell plates can be diminished, which will materially reduce the cost of the boiler for the same capacity. The "ogee" plate or flange as a rule gives little or no trouble.

As to increasing the number of tubes in a horizontal return-tubular boiler, this would seem entirely unwarranted in most conditions. In the first place, it greatly reduces the water space of the boiler, making it possible to burn out the upper row of tubes or greatly diminish the steam space, with the result that water would likely be carried over with the steam. Further, the narrow spacing required makes the circulation bad, and it is almost impossible to get at and clean the shells, which even in present boilers is hard enough. Unless boilers are built with far more care than is ordinarily the case the tube sheets are likely to give more or less trouble.

Boilers larger than 84 inches require very heavy plates, and offer a splendid opportunity for burning them at the joints unless they are built with very great care. It seems doubtful if, taking all things into consideration, the increase of boilers to over 84 inches in diameter is warranted.

On the whole, it seems very curious for Mr. Dean to advise increasing the capacity of vertical boilers by increasing the number of tubes, as the boilers of the design for which he is responsible have as a rule far less capacity for the same space than any other boilers of equivalent size. I am speaking now of the boilers which he has designed for the city of Boston, where he has used the Scotch type, whose capacity of 116 horsepower is small compared to a horizontal return-tubular boiler that can be installed in the same space.

HENRY D. JACKSON.

Boston, Mass.

Value of Flue Gas Analysis

Having carefully read the article by Joseph W. Hays in POWER for June 6, entitled "Value of Flue Gas Analysis," I feel pleased to say that with few exceptions Mr. Hays' views on the matter come nearer to the solution of the fuel-wasting problem than any of the boiler and furnace equipments which have been introduced and installed for fuel-economy purposes.

It is certainly true that the average fireman is somewhat lame when the subject of furnace chemistry is suggested, not alone in the lack of education on the matter but largely from the fact that he does not consider such knowledge necessary, for the reason that fuel used in the boiler room was not taken into account as a very costly item. While it requires very little study for the fireman to become familiar with the chimistry of fuel or gas combustion in a steam-boiler furnace, it takes years of repeated efforts to become familiar with the practical requirements.

If chief engineers would not be so narrow-minded and would impart the necessary knowledge to the firemen and others in their charge, their work would be more pleasant and the plant as a whole would at all times develop the highest possible efficiency. It is a sad commentary on the organization of a power plant when persons therein are not familiar with all of the essential features; and a sad reflection on the effort of the chief when he says that his fireman would not learn the laws governing the chemistry of a furnace or understand a CO_2 recorder in a thousand years; this is simply rot.

Statistics show that the best engineers are men who are practically trained in the boiler room, and men of this class never boast that their coal consumption averages about 3 pounds per kilowatt or that they get an evaporation of from 10 to 11 pounds of water per pound of coal, because they know that such results cannot be accomplished by any grade of coal on the market. If more attention were given to the employment of good firemen, who could be instructed as to when their fires should be coaled and cleaned; how to regulate properly the air supply so as to guard against serious changes in furnace temperature; and how to avoid as much as possible surplus boiler capacity, they would then show a far greater saving in fuel than can be done by installing pressure-reducing valves, CO_2 recorders, draft-pressure gages, automatic damper regulators and unnecessary steam traps.

Mr. Hays no doubt is aware of the fact that the mechanical engineers have reached the limit in designing steam boilers and steam-boiler furnaces, especially so on the factor of efficiency and economy, and it matters not how good the whole equipment may be or what quality of coal is used if the important particulars are lost sight of, such as attention to temperature and capacity; all other efforts toward efficiency and economy in the performance of the plant will be in vain.

Therefore, chief engineers as well as chief firemen should broaden out in their treatment of their firemen, and carefully instruct them in the performance of their duties; they should encourage them in improving their efforts to qualify for the high positions in the engineering line. This in time will make them more proficient in steam-boiler and steam-engineering work than is the average technical graduate who is fast relegating the practical man to the rear on nothing but pencil and pad work.

J. J. MCANDREW.

Scranton, Penn.

Coal Defined

In the issue of May 30, William Kent presents a criticism of my article, "The Coal Problem Analyzed," which appeared in the issue of April 25. He objects to my invention of new terms, such as "fuel mixture" and "coal fuel," as being neither necessary nor justifiable. I think the reason for my adopting such new terms was so clearly set forth in the article that the readers of POWER may judge for themselves as to the merits of the case.

It seems well to call attention to the danger of being overconservative in matters of this kind. It is, of course, true that an unnecessary word or term, or any useless thing for that matter, is objectionable. But the history of all languages contains unending examples of new words and terms, made necessary by the progress of civilization and the arts. The Century dictionary, to which reference is made, is an instance, as it was necessary to issue 10 volumes instead of a lesser number because of the new words and definitions that must be included, but which had been absent in other dictionaries. Because people thought for several hundred years that the world was flat was no reason why the more authentic view of its spherical form should not have been accepted.

Since preparing the foregoing, Mr. Kent's correction appearing on page 927 of the issue of June 13 has come to my attention. At the time, not being able to gather his meaning, I did not attempt an explanation. It is now clear, however, that he proposes (as he has many times before) a different definition for the term "pure coal." When I began

to study the coal problem several years ago, I found that the ash- and moisture-free coal was universally called "combustible" by engineers. As I wished to use the word in its correct sense, namely, to define the combustible elements, I adopted the term "pure coal." Mr. Kent's argument is not consistent. He maintains that pure coal should consist only of combustible elements, not conceding to it oxygen and nitrogen; yet he would have "coal" consist of coal and dirt.

A. BEMENT.

Chicago, Ill.

Pins in Loose Crank Pins

In POWER for July 18, B. W. Robinson sizes up the loose crank-pin subject quite well; but we have dealt successfully with the same problem in a different and, I fancy, better way.

We drill and ream a taper hole in the center of the pins to quite the depth of the crank, and drive in a taper pin. (Do not heat the crank pin as that closes up the hole, contrary to one's first notion.) The first job of this kind we had was when the main bearing of a Corliss engine 10-inch cast-iron shaft got hot and expanded the crank until it became loose. We drilled and reamed a 2¼-inch hole in the center, after the foreman had failed in helping it with a 1¼-inch taper pin in the joint. The tapered steel pin driven in the middle of the shaft helped matters considerably, but did not cure it until the shaft again became heated, and the crank set tight; it has remained so for about 45 years.

We have repeatedly turned the same trick on crank pins successfully.

JOHN E. SWEET.

Syracuse, N. Y.

Poor Draft

I read Mr. Cotton's description of his draft troubles in the July 4 issue. A smoke connection should have a sectional area at least equal to that of all the tubes in the boiler which it serves. In Mr. Cotton's layout this is not the case which, no doubt, is part of the reason for the sluggishness of the draft. The total area of the 70 tubes, 4 inches in diameter, in each boiler is 880 square inches while the area of the uptake connection, 10 inches wide by 67 inches long, is only 670 square inches.

Further, the area of the stack itself is only 2290 square inches while the total tube area for all three boilers is 2640 square inches. Thus the stack itself is much under the proper size.

The commercial capacity of the stack is about 400 horsepower while that of the three boilers is about 480 horsepower.

I think that the only remedy Mr. Cotton can apply is to increase the size of the smoke connections and stack or else put in a small blower to increase the draft power.

C. R. MCGAHEY.

Baltimore, Md.

Advantages of Open Feed Water Heaters

The answer given to O. C. H.'s question in the July 18 issue of POWER, "What are three advantages of an open heater over the closed feed-water heater?" is very good, but does not mention half the advantages.

First, some types of open heater will maintain a higher temperature of the feed water.

Second, it is generally used as a receiver for the return from the heating system, thus saving the expense of a return tank necessary to supply the feed pump when closed heaters are used.

Third, with proper baffle plates and float valves it acts as an oil separator, collecting the cylinder oil from the exhaust steam and conveying it to the soil pipe, thus keeping it out of the boilers and heating systems. With the overflow controlled by a float valve it will also act as a return trap, keeping the end of the return pipe water sealed, and preventing the escape of steam if live steam is used for heating when the engine is not running.

With the Cochrane feed-water heater the temperature runs from 200 to 214 degrees, and the greatest trouble was to prevent the feed water from becoming too hot, or the feed pump would become steam bound.

R. A. CULTRA.

Cambridge, Mass.

Hot Boxes and Some Cures

I have been reading with much interest the various articles on hot boxes and the many different remedies used, sulphur being the bone of contention. The proper kind to use is what is called flour of sulphur, and not the ordinary commercial kind. Being the flour of a solid substance, we must remember that if it is subjected to pressure or confined in too close a space in a bearing the results are as liable to prove detrimental as beneficial. Like graphite, sapolio, soapstone, etc. it must be used with oil in the proper proportion and be kept moving in order to do anything toward cooling the bearing. The use of sulphur in a bearing will give a beautiful gloss if any results are obtained at all.

Most any of the so called flour or powder remedies are good to use in a bearing when there is sufficient jar or room to allow these substances to work under and around the shaft, such as is afforded in the main bearings of most engines. Be careful of what you do when it comes to handling close bearings, such as outboard bearings on engines, motor bearings or any bearing where there is no vibration or thrust to assist the working of the remedies. Cylinder oil, white lead and refined tallow are good remedies for close bearings, either brass or babbitt lined. Mr. Holly's water remedy will work all right on brass- or composition-lined boxes, but in babbitt-lined ones I would advise a close observance of temperature of the bearing before applying water, or queer things may happen. Good castor oil free from resin or other body substances is frequently used with good results in cases of chronic heating. Pure white lead is about as effective when mixed with either linseed or cylinder oil as any remedy I have tried.

To cool any hot box one should always select such remedies as are in themselves good lubricants and of higher fire or flash test than the possible temperature of the bearing. Locate the cause and it will usually suggest the remedy.

THOMAS M. STERLING.

Middlebranch, O.

Sizes of Belts

In "Notes on the Size and Care of Belts" in the July 4 issue of POWER, W. R. Willard, in giving his method for finding the width of belt necessary to transmit a given power, seems to have confused the difference $T_1 - T_2$ with the quantity T_2 itself. Using Mr. Willard's notation, the difference P in belt pull on the tight and slack sides of the belt is also equal to the difference $T_1 - T_2$, as these quantities are defined at the bottom of the table. The width of belt is based on T_1. To find T_1, Mr. Willard multiplied his value for P by the value of $T_1 \div T_2$ taken from the table; he has evidently called $P = T_2$, whereas $P = T_1 - T_2$.

Having $T_1 - T_2 = 218.8$ pounds and $T_1 \div T_2 = 2.311$, we can easily solve for T_1, obtaining $T_1 = 385.7$ pounds. Using Mr. Willard's assumption that single leather belting will pull with safety 80 pounds per inch of width, the required width will be 4⅞ inches instead of 6⅝ inches as found by Mr. Williard.

It is true that as an approximation $T_1 - T_2$ is often taken equal to T_2, but this necessarily makes $T_1 \div T_2 = 2$, corresponding to an arc of contact of 180 degrees and F = about 0.22; we cannot take $T_1 \div T_2$ from the table and still use $T_1 - T_2 = T_2$. The correct method is to find P, or what is the same thing $T_1 - T_2$, as Mr. Willard has done, from the power to be transmitted and the belt speed. Then take $T_1 \div T_2$ from the table according to the conditions of the case, and solve for T_1. This value of T_1 divided by the assumed safe load per inch of width will give the width of belt re-

quired. This method reduces to the following formula:

Let

S = Speed of belt in feet per minute;

H = Horsepower to be transmitted;

R = Ratio of tensions, $T_1 \div T_2$ as found from table;

L = Safe working load per inch of width of belt;

W = Width of belt in inches.

Then

$$W = \frac{33{,}000 \times H \times R}{S \times L \times (R - 1)}$$

Thus in the problem under discussion we have

$$W = \frac{33{,}000 \times 25 \times 2.311}{3770 \times 80 \times 1.311} = 4\tfrac{7}{8} \text{ inches}$$

The value of 80 pounds for safe working load per inch of width, as taken by Mr. Willard, is rather high for single leather belting, 60 pounds or less being more often used.

WILLIAM EARL MOSHER.

Mechanicsville, N. Y.

Putting in Gage Glasses

In a letter under the above title in POWER for June 20, Mr. Little says that the washer furnished with the gage fixtures is often placed in the bottom of the nut. That is just where it should be placed. If it is not so used the glass will often be twisted off by reason of the adhesion between the nut, packing and glass, despite the use of graphite.

GEORGE R. WILLIAMS.

Findlay, O.

Central Station versus Isolated Plant

In POWER for July 11 I noticed an article by Emmet Baldwin entitled "Central Station versus Isolated Plant" and one by Mr. Westerfield under the title, "Writing for the Technical Paper." I heartily agree with the latter gentleman, whose words are designed to help those who are backward in giving others the benefit of their experiences. His article and that of Mr. Baldwin compel me to say a few words. I am interested only because I am an engineer in an isolated plant. I do not like to criticize, yet there is an opening for discussion.

I believe Mr. Baldwin has given up his plant too easily; because he did his own firing does not establish the fact that he was getting the best results from the coal. The condition of the boiler is to be considered as well as that of the engine. A great many engineers think that if the engine is all right and running economically they have nothing to fear. They never stop to think whether the condition of the boilers can be improved.

Just how much coal Mr. Baldwin means when he says, "somewhat more than two tons" is not known. If he had checked up he would have known exactly how much he was using and what the watchman was using. Then, he could have given accurate figures as to how much it cost to develop the power required, and whether the conditions could have been bettered.

I will endeavor to give a little of my experience in this discussion. In the first place, I keep an account of all of the coal delivered to my plant. I frequently indicate my engine and check up on my fireman. The engine is developing 112 horsepower. The fireman has demonstrated time and again that he can fire the boiler with 392 pounds of coal per hour or 3½ pounds per indicated horsepower per hour. For a ten-hour run it will take 3920 pounds of coal.

Last winter I was called on to check up with the firm. The figures showed more coal than they thought necessary, so I checked up on the fireman and found him to be within the limits. Then I thought the trouble must be with the watchman as he had never been on duty in the winter when we had to have the plant heated. I gave him a few lessons in handling his fire. The result was we saved nearly 7½ tons of coal in the next month. This is quite an item for a beginner.

My point is this: If the isolated plant can produce power at or in the neighborhood of 3½ pounds of coal per horsepower-hour and heat the building with the exhaust steam in the winter time, the engineer need have little fear of the central station. What is wanted in the isolated plant is wide-awake and up-to-date engineers. Then the central-station man will have a hard time to displace them.

A. C. SCHNEIDER.

De Soto, Mo.

Belt Drives

In the July 4 issue the article by W. R. Willard contains some very useful information and with one exception is correct; his suggestion of the second tightener, shown by dotted lines in Fig. 3 of his article, I think is wrong.

In a small electrically driven plant I had been called to install some machinery which included a vertical drive with a tightener to allow for stopping a part of the plant if required, as the firm did not want to install a friction clutch on account of the cost. The plant was idle when I arrived, owing to a burned-out motor. The direction of rotation of the shafting was given me by one of the owners and the required shafting put up. When I started up to try things out I found the shafting was turning in the opposite way from the direction the owner had given me, and my tightener was on the side as the one shown by Mr. Willard in dotted lines, assuming the belt to be turning to the left. As the driving and other conditions would not allow reversing the motor, I decided to make the tightener work. I did this by a liberal application of old junk as a weight and I was surprised at the amount it required to make my shaft turn when the load came on. That night I changed the tightener to the other side and it did its work easily without any weight except its own, and the bearings ran several degrees cooler.

In another case I had charge of a mill of which the upper-floor machinery was driven by the vertical belt and tightener system.

Wishing to stop the shafting on this floor and not interfere with operations on the floor below, I sent a man down to raise the tightener; he did and secured it with the latch provided for that purpose. When he came back to assist me the speed had not slackened in the least, so I went below myself to investigate. I found the belt, which was 16 inches wide, hugging the small pulley in the same position that it should had the tightener not been removed. It took some little effort to persuade the belt to let go.

With these two experiences in mind I am convinced that the tightener should be on the slack side of the belt where the sag will assist it in taking up the slack and not on the tight side, which has a tendency to run straight, owing to the pull.

Mr. Willard's argument of getting a large arc of contact on the small pulley is a good one, but it will take less power to run the shafting if this increased arc of contact is obtained with one idler, which can be done by leaving the belt longer and letting it run as close to the tight side as is required to get the maximum efficiency.

CHARLES F. KING.

Portland, Ore.

Receiver Pressure

In June 27 number of POWER, E. H. Lockwood takes exception to my statement that the shorter the cutoff in the high-pressure cylinder the less is the consumption of steam. I do not think his illustration of the pump going faster with higher receiver pressure and slower with less receiver pressure proves anything, for the engine has no governor at all; besides, the load and relative sizes of the cylinders have all to do with the necessary receiver pressure. I would not care to tell the exact receiver pressure best to carry, but I think where both cylinders are working under the best condition with regard to pressure, it will be found that either raising or lowering the receiver pressure will cause the governor to revolve in a lower plane and a greater amount of steam will be consumed.

L. JOHNSON.

Exeter, N. H.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Capacity of Taper Tanks

I have a tank forming the frustum of a cone. The bottom diameter is 5 feet, the top diameter is 4 feet and the hight is 5 feet. How can I find my marks for 100 gallons, 150 gallons, 200 gallons, etc.?

A. O. L.

To mark off on a tank which is the frustum of a cone the hight to which a given volume of liquid will fill it requires the calculation of the contents of the cone of which the frustum is a part and the hights of the several cones each of which shall contain a specified volume less than the original cone.

The hight of the whole cone of which the tank is a frustum is 25 feet, containing 1223 gallons. As the volume of all solids is proportional to the cubes of their corresponding dimensions, a cone having a volume of 1123 gallons will have a hight expressed by the proportion

$$1223 : 1123 : : 25^3 : x^3$$

To shorten the operation it may be changed to read

$$\sqrt[3]{1223} : \sqrt[3]{1123} :: 25 : x$$

then

$$\sqrt[3]{1223} = 10.694$$
$$\sqrt[3]{1123} = 10.3943$$
$$10.694 : 10.3943 : : 25 : 24.29$$
$$x = 24.29$$
$$25 - 24.29 = 0.71 \textit{ foot}$$
$$0.71 \times 12 = 8.52 \textit{ inches}$$

the hight to which 100 gallons will fill the tank.

For the next mark subtract 150 from 1223 and proceed as before

$$1223 - 150 = 1073$$
$$\sqrt[3]{1223} : \sqrt[3]{1073} :: 25 : x$$
$$10.694 : 10.2376 : 25 : 23.93$$
$$25 - 23.93 = 1.07 \textit{ feet}$$
$$1.07 \times 12 = 12.84 \textit{ inches}$$

the hight of mark for 150 gallons, and so on until the desired number of marks is made.

Compressor Capacity, Horsepower and Piston Speed

How is the capacity of an air compressor computed? How is the horsepower computed? What is the most economical piston speed for an air compressor?

H. C. E.

The nominal capacity of air compressors is commonly reckoned to be the theoretical piston displacement. The actual capacity is the piston displacement multiplied by the volumetric efficiency which is the *actual piston displacement* divided by the theoretical. This does not include the leakage of air past the piston.

The indicated horsepower in the air cylinder is for simple stage compression,

$$I.H.P. = 1.51\, P_1\, (R^{0.29} - 1)$$

and for two-stage compression with intercooling and with equal compression ratios in the two cylinders.

$$I.H.P. = 3.02\, P_1\, (R^{0.145} - 1)$$

in which

P_1 = Absolute initial pressure;
R = Total ratio of compression.

For the air cylinder alone a low piston speed is more economical than a high one, but when other factors are considered, the highest practicable speed (depending on valve area, etc.) is the most economical.

Fusible Plugs

Why should the least diameter of fusible metal in a fusible plug be not less than ½ inch, and why should the plug project through the sheet 1 inch or more? Why not use an inside plug on a return-tubular boiler? What types of boilers have inside plugs?

J. C. O.

The diameter of fusible metal is made ½ inch to avoid a possible choking of the orifice by scale or floating sludge and to allow steam enough to escape to attract attention. The plug projects through the plate 1 inch to prevent the catching of floating matter that would be close to the head. Outside plugs are used in return-tubular boilers because they are more accessible than inside ones. Inside plugs are used in vertical fire-tube boilers and the fusible metal is usually ⅜ inch diameter because a larger diameter will not easily make a good joint in a boiler tube.

Safety Valve Area

How many square feet of grate surface would be allowed for a safety valve 3 inches in diameter?

W. G. A.

The Massachusetts formula for spring-loaded safety valves is

$$A = \frac{W\,70}{P} \times 11$$

in which

A = Area of valve in square inches per square foot of grate;
W = Pounds of water evaporated per second per square foot of grate;
P = Absolute pressure at which the valve opens.

As the valve area depends on the amount of steam made and its pressure, these must be assumed to find the grate area to fit the valve. Take 160 pounds of water evaporated per hour per square foot of grate into steam at 100 pounds gage pressure. Then the weight evaporated per second will be 0.0444 pound, and substituting the values in the equation it becomes

$$\frac{0.0444 \times 70 \times 11}{115} = 0.297 \textit{ square inch}$$

of valve area for each square foot of grate. The area of a 3-inch valve is 7.0686 square inches and it will take care of as many square feet of grate area as 0.297 is contained times in 7.0686.

$$\frac{7.0686}{0.297} = 23.45 \textit{ square feet}$$

Air Required to Burn Coal

How do I compute the quantity of air required to burn 1 pound of coal having 80 per cent. carbon, 7 per cent. hydrogen, 10 per cent. oxygen and 3 per cent. ash. What is the heat of combustion?

R. B. C.

The air theoretically required to burn one pound of coal is expressed by the formula

$$11.52\,C + 34.56\left(H - \frac{O}{8}\right) + 4.32\,S = air$$

in which

C = Per cent. of carbon;
H = Per cent. of hydrogen;
O = Per cent. of oxygen;
S = Per cent. of sulphur.

Hence

$$11.52 \times 0.80 + 34.56\left(0.07 - \frac{0.10}{8}\right) =$$
$$11.203 \textit{ pounds}$$

The heat value of the fuel is 14,600 B.t.u. for the carbon, 62,000 B.t.u. for the hydrogen.

$$14{,}600 \times 0.80 + 62{,}000\left(0.07 - \frac{0.10}{8}\right) =$$
$$15{,}245 \textit{ B.t.u.}$$

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Contents

PAGE

Extension of Redondo Beach Plant..... 198
Value of a Vacuum..... 202
Bleeding Receiver to Heat Feed Water.. 203
Mean Pressure of Expanding Steam..... 204
Error of Indicator Reducing Rigs..... 206
Speed versus Economy of Engines..... 207
The Price Water Current Motor..... 208
Installation of Small Stationary Engines 209
Gas Engine Ignition Equipment..... 210
Crude Petroleum..... 211
Producer Capacity When Operating on Lignite 211
Unusual Packing Ring Reinforcement... 211
The Remek Transformer..... 212
The Electrical Section of the Bureau of Mines 213
Two-Phase, Three-Phase Transformer Connections 214
Cutting Out Dynamos from Parallel Service 214
Practical Letters:
Receiver Pressure Spring Rods.... Smoke Preventer....Clogged Condenser Gage Pipe....Lifting Water in Boilers....Running a Pump with Broken Cylinder Head....Repaired Engine Frame....Oiling Kinks.... Preventing Steam Turbines from Racing 215-217
Discussion Letters:
Poor Draft .... What Causes the Pipe to Wear....Boiler Management ....Boiler Design....Value of Flue Gas Analysis .... Coal Defined.... Pins in Loose Crank Pins....Advantages of Open Feed Water Heaters....Hot Boxes and Some Cures ....Sizes of Belts .... Putting in Gage Glasses .... Central Station versus Isolated Plant .... Belt Drives 218-221
Editorials 223-224
Cold Losses through Insulation..... 225
Questions on Refrigeration..... 226
Turbine Accident at Riverton, Ill..... 227

POWER

Condensers

In stationary work the jet type of condenser is still holding its own because of its much lower price and equal if not superior adaptability to the needs, particularly in situations where fresh water is available for condensing, allowing the feed to be taken from the overflow of the hotwell at a temperature depending on the vacuum carried.

The statement is often made that there is an element of danger in the operation of a jet condenser because it is possible under certain conditions to flood the engine cylinder and cause a wreck.

There is an element of danger in the operation of any machine, however simple it may be, if put into the hands of unskilled men. But with the intelligent engineer there is no more danger of accident to the engine from the jet condenser than from any other part of a modern power plant.

With the surface condenser the possibility of getting water into the steam cylinder is, of course, eliminated, but this is no reason why its operation should be entrusted to an unqualified man as there are ways of wasting money in a power plant other than by wrecking engines.

In many situations the surface condenser is to be preferred to the jet for reasons that are seldom recognized. Accurate records of the amount of water fed to the boilers may be kept, but these records afford no information as to the proportionate quantity of steam that is being used by each or any unit in a condensing plant where more than one unit is used. Weighing the water drawn from a surface condenser and comparing this weight with indicator diagrams or with switchboard records for any given period will furnish information that can be gotten in no other way.

In many large and some small plants the discharge from the air pumps of the surface condensers is piped directly to weighing tanks so that the water consumption of any unit operating under any condition may be measured at any time without preparation.

There come times of emergency in every plant and one of these times may be caused by a near or distant fire or by the water being shut off in the vicinity of the plant for repairs or changes in the water main, causing a temporary curtailment or perhaps a complete stoppage of the feed water supply. In such a case the surface condenser with its air-pump discharge piped to a reservoir from which the feed pump may draw is invaluable if continuous service is desired.

Massachusetts Standard Boiler Rules

That the standard is high for the Massachusetts boiler rules is amply evidenced by the facts brought out at the twenty-third annual convention of the American Boiler Manufacturers' Association recently held in Boston, Mass.

It is claimed that, conservatively estimated, there are 24,000 boilers under the provisions of the boiler-inspection law, and that less than two one-thousandths of one per cent. of this number of boilers in use in the State of Massachusetts show any explosion. This low percentage is believed to be due chiefly to the specified boiler design and the rigid inspection laws that are well administered and thoroughly and practically formulated.

The State is divided into seventeen districts and twenty-five inspectors hold certificates of competency as inspectors of steam boilers. That the Commonwealth fully believes in the good that is being accomplished by the steam-boiler inspection department, is evidenced by the appointment recently of five additional inspectors.

While some opposition was manifested at the convention to the proposal that the Massachusetts standard boiler rules be made standard for all boiler manufacturers throughout the United States, it appeared to be the general belief that, with some slight changes in detail as necessary to local conditions, the rules of the Bay State were best adapted to the States as a whole.

A number stated that the high standard set by Massachusetts is favorably known outside the confines of this country, and manufacturers have been asked to figure on boilers built under this standard in the Philippines, Constantinople, China and Japan.

Its most earnest adherents did not claim that the Massachusetts standard was flawless; they said they were ready at all times to modify a rule where sufficient reason could be shown.

Redondo

In this issue we describe the enlargement of the Redondo Beach generating plant. At the time of its erection this was perhaps the most widely advertised central station in America by virtue of the decision of the engineers to install 5000-horsepower reciprocating engines in preference to steam turbines. It was almost universally expected that the engineers would follow the lead established by the New York Edison Company, the Boston Edison Company and the Commonwealth Edison Company, of Chicago, all of which had declared in favor of the turbine by installing this type of prime mover in their stations.

When the results of the acceptance tests at Redondo were made known, the engineering world was startled by the fact that a world's record for overall plant efficiency had been established Something like 235 kilowatt-hours had been generated per barrel of oil. But, just what part the engines played in the securing of this result was never publicly made clear. The opinion is prevalent, however, that the record was established not so much through any surpassingly high engine efficiency but by getting from each individual piece of equipment the best results it was capable of yielding. Paraphrasing a familiar axiom it might be said that they took care of the small individual efficiencies and the big overall efficiency took care of itself.

When the enlargement of Redondo was announced, speculation became rife as to what type of prime mover would then be selected. Few expected that more reciprocating engines would be put in; the points in favor of the turbine were too obvious to permit of such an expectation. In view of the showing made by the exhaust-steam turbines in the Fifty-ninth street station of the Interborough Rapid Transit Company that type of machine seemed the logical selection. However, the time element threw it out of the running and the high-pressure turbine was selected.

In southern waters the marine-plant growths are rank and almost endless in variety. During certain times of the year weeds and leaves float about in huge masses below the surface of the water. The problem of excluding this decaying vegetation from the circulating-water system without too great an expenditure for duplicate equipment or the employment of an excessive amount of manual labor has been no easy one to solve.

That the original circulating-water system at Redondo did not constitute a satisfactory solution of the problem was made evident by the numerous interruptions that occurred in the condensing-water supply. If complete-expansion turbines are to be of any use whatever they must have an ample and continuous condensing-water supply. Realizing this, J. G. White & Co., the consulting engineers for the work of enlargement, spent some hours in earnest thought and evolved the circulating-water system described in the article appearing in this issue. It is radically different from the original arrangement and its simplicity, low first cost and efficiency stamp it as being an unqualified success.

Riverton Turbine Accident

Boiler explosions, on account of their frequent occurrence, now cease to excite more than a passing or a local interest, unless extremely disastrous in extent, or occurring under unusual circumstances. Similarly, flywheel explosions have become more or less common, and the causes which lead to them are usually obvious. A turbine explosion, however, is rare. This fact, together with the apparently normal conditions under which the accident occurred at Riverton, will furnish a topic for much speculation among the engineering fraternity.

If the turbine was running at half speed when the accident happened, as stated by an eye witness, then it is plain that it was not due to an old fracture in the metal or to any inherent defect in design; for the machine had been operated for several years at normal speed without giving the slightest trouble. According to this, the theory that some foreign object had become lodged between the rotating and stationary parts would seem plausible.

On the other hand, if the governor failed to operate properly and the machine speeded up, the cause of the accident can be easily explained.

On account of the reluctance of the company to give out information and their strict rules barring the use of the camera, it is difficult to form a conclusive opinion which would be of benefit to engineers operating other turbine plants.

Opportunity for the Isolated Plant

One of the weapons of the central station in its arguments against the isolated plant has been that the latter is handicapped by a low load factor. According to the latest developments in the controversy now being waged in New York city, the central station adherents will have to look to other lines to back up their case.

The Longacre Light and Power Company, which has long been fighting a legal battle for a franchise in New York City, has at last received permission from the Public Service Commission to issue bonds to the extent of fifty million dollars. Furthermore, they may use the present street conduits for their cables.

One of the first moves of this company has been to issue a statement to isolated-plant owners that they stand ready to purchase all excess power of such plants at one and one-half cents per kilowatt-hour during the daytime and at one and one-quarter cents at night.

This would enable the isolated plants to be run at one hundred per cent. load factor all the time, and the only additional expense would be for coal. Thus the cost of producing electrical energy would be cut down materially and their position rendered more secure against present central-station encroachments.

The opportunity appears to have arrived for the small plants to show what they can do.

Silent Running Engines

In deciding the degree of compression necessary to produce a quietly running engine, the engineer frequently calculates the momentum of the moving parts by multiplying their estimated weight by the average speed of travel.

While the speed of the crank pin is uniform throughout the stroke, the speed of the piston ranges from zero at the beginning of the stroke to approximately that of the crank at midstroke, or more than three times its average speed.

But as it approaches the end of its travel the rate of speed rapidly diminishes, and at the end again becomes zero.

The amount of compression needed to transfer the pressure from one side of the pins and main bearing to the other at or near the end of the stroke is but little above the terminal pressure on the opposite side of the piston, and if calculated for the average speed of the piston for the last few inches of the stroke it will be found sufficient for most if not all cases.

In the reversal of pressure from one side of all the bearing surfaces to the other the change must be gradual if quiet running is expected. But any pressure in excess of what is required for this change acts as a brake on the engine and reduces its efficiency.

Where the compression is slight, the lead, if excessive, will hasten the incomplete reversal of pressure to an extent that will make silent operation impossible.

It is excessive lead rather than the lack of sufficient compression that is often the cause of noisy operation, and the engineer finding relief in increased compression hastily concludes that quiet running is impossible without it.

Refrigeration Department

Principles and operation of ice making and refrigerating plant and machinery

Cold Losses through Insulation

By F. E. Matthews

There is no known means of accurately determining loss of refrigeration through the opening of cold-storage doors, although it might be roughly approximated from formulas giving the flow of gases under slight differences in pressures, in which case some delicate form of draft gage might be employed to show the excess pressure of the cold air on the inside of the cold-storage compartment over that of the outside air. The area through which the outward flow due to the observed difference of pressure would take place would be probably about one-half of that of the opening offered by the door, because in a single opening the upper part would be given up to the inward current of warm air.

While it would be difficult to estimate the velocity at which cold air rushes out of a cold-storage compartment, it is apparent that it will increase as the difference between the inside and outside temperatures and with the increase in hight of the cold-air column, both of these factors acting to effect an unbalancing of the atmospheric pressures and consequently tending to produce a flow.

In this connection it may be remarked that the circulation of air in cold-storage compartments, as well as currents of air entering and leaving the compartment, can be conveniently studied by using smoke as an indicator. It might be possible by means of a puff of smoke and a stop watch, in the absence of a delicate anemometer, to roughly determine the velocity of the air currents. The inward current would have a maximum velocity at the top of the opening and the outward current at the bottom, while somewhere near midway would be found a place with no perceptible current. From this it follows that the volume of air lost through the opening might be determined by multiplying one-half the area of the opening by one-half the maximum velocity. The product of the average velocity in feet per minute and the area of the current will be the number of cubic feet per minute lost through the opening, and, since 4000 cubic feet per minute cooled one degree requires refrigeration at the rate of one ton per 24 hours, it follows that outside air at a temperature of 80 degrees Fahrenheit, rushing into the cold-storage compartments to take the place of cold air escaping at a temperature of 40 degrees Fahrenheit, requires an additional ton of refrigeration for every 100 cubic feet of flow. To reduce this excessive loss to a minimum, vestibules sufficiently large to permit one door to be closed before the other is opened are often provided for doors communicating directly with the outside. Where products alone are to be passed, rotary doors, or in the case of ice-storage rooms, automatically closing swing doors may be advantageously employed.

Insulation Losses

Good heat insulators are simply poor heat conductors and poor heat insulators good heat conductors—the property of each being numerically the reciprocal of that of the other. Since all heat insulators are to some extent heat conductors, the flow of heat through insulated walls cannot be prevented but only reduced in proportion to the thickness and efficiency of the insulation used. The amount of heat that will pass through a square foot of cold-storage insulation per 24 hours, like that through other more or less imperfect conductors, is practically proportional to the difference in temperature on the two sides of the insulation and to the efficiency of the material not as a heat insulator but as a heat conductor.

Products cooled to the temperature of the cold-storage compartment where uniform temperatures are maintained require the expenditure of no further refrigeration. Exceptions to this general rule are products which are fermented while in storage, the process of fermentation giving rise to the evolving of a considerable quantity of heat.

The necessity for operating the refrigerating plant for the preservation of the cooled products is therefore due largely to the entrance of heat through the insulated walls of the cold-storage compartments and the insulation should be made as efficient as economy will permit. True economy at the point where cost of refrigeration would otherwise be lost is balanced up against the cost of the insulation effecting the saving. Obviously, the more it costs to produce a ton of refrigeration the more it is economy to employ insulation to conserve the refrigeration produced.

Thermal conductivity varies widely among the so called insulating materials and even with the same material when varying percentages of air and moisture are present. Table 1 shows the amount of refrigeration expressed in B.t.u. per square foot per 24 hours per degree dif-

TABLE 1. HEAT CONDUCTIVITIES OF COLD STORAGE INSULATION

Transmission in B.t.u. per square foot per degree difference in temperature inside and out per 24 hours. Compiled principally from information published by the Armstrong Cork Company.

	B.t.u.
Insulating Slabs.	
1″ "Nonpareil" cork board (pare cork, no foreign binder)	6.5
1″ "Rock" cork (waterproofed rock-wool composition board)	7.4
1″ "Lith" Plain (mineral-wool flax-fiber composition board)	7.9
1″ "Lith" waterproofed (same as above waterproofed)	8.4
1″ impregnated cork board (granulated cork and asphaltic binder)	8.9
1″ indurated fiber board (indurated wood-pulp board)	10.0
Built-up Insulation (wood and air space).	
1″ American spruce	16.80
(1″ dressed and matched spruce (⅛ sp.) paper, ⅛ sp.) (⅛ sp. paper ⅛ sp.)	4.75
(⅛ sp. paper ⅛ sp.) (1″ air space) (⅛ sp., paper, ⅛ sp.)	4.25
6 thicknesses, ⅛ sp., 3 papers, 2 air spaces arranged as above	3.45
8 thicknesses, ⅛ sp., 4 papers, 3 air spaces arranged as above	2.70
10 thicknesses ⅛ sp., 5 papers, 4 air spaces arranged as above	2.70
(8 thicknesses being ⅛ and 2 thicknesses being ¼″ thick)	
Built-up Insulation, Wood, Paper and Fill.	
(⅛ sp. paper, ⅛ sp.) (⅛ sp. paper, ⅛ sp.)	4.75
(⅛ sp. paper, ⅛ sp.) (4″ mineral wool) (⅛ sp. paper, ⅛ sp.)	2.20
(⅛ sp. paper, ⅛ sp.) (8″ mill shavings, damp) (⅛ sp. paper, ⅛ sp.)	2.10
(⅛ sp. paper, ⅛ sp.) (1″ mill shavings, dry) (sp. paper ⅛ sp.)	1.35
(⅛ sp. paper, ⅛ sp.) (8″ granulated cork) (⅛ sp. paper, ⅛ sp.)	1.90
(⅛ sp. paper, ⅛ sp.) (1″ nonpareil cork) (⅛ sp. paper, ⅛ sp.)	3.10
(⅛ sp. paper) (1″ nonpareil cork) (paper, ⅛ sp.)	3.25
(⅛ sp. paper) (2″ nonpareil cork) (paper, ⅛ sp.)	2.60
(⅛ sp. paper) (3″ nonpareil cork) (paper, ⅛ sp.)	2.25
(⅛ sp. paper) (4″ nonpareil cork) (paper, ⅛ sp.)	1.20
(⅛ sp.) (1″ pitch) (⅛ sp.)	4.90
(⅛ sp.) (2″ pitch) (⅛ sp.)	4.25
Built-up Insulation (*Wood, Paper, Air Space and Fill*).	
(⅛ sp. paper, ⅛ sp.) (1″ air space) (⅛ sp.) (6″ min. wool) (⅛ sp., paper, ⅛ sp.)	1.49
(⅛ sp. paper, ⅛ sp.) (1″ air space) (⅛ sp.) (6″ gran. cork) (⅛ sp., paper, ⅛ sp.)	1.46
(⅛ sp. paper, ⅛ sp.) (1″ air space) (⅛ sp.) 2″ nonp. cork) (⅛ sp., paper, ⅛ sp.)	1.60
(⅛ sp. paper, ⅛ sp.) (1″ air space) (2″ nonpareil cork) (paper, ⅛ sp.)	2.10
(⅛ sp. paper, ⅛ sp.) (1″ air space) (3″ nonpareil cork) (paper, ⅛ sp.)	1.70
(⅛ sp. paper, ⅛ sp.) (1″ air space) (4″ nonpareil cork) (paper, ⅛ sp.)	1.20
(⅛ sp. paper, ⅛ sp.) (1″ air space) (5″ nonpareil cork) (paper, ⅛ sp.)	0.90
Brick Wall and Sheet Cork.	
(13″ brick wall) (2″ nonpareil cork)	2.75
(13″ brick wall) (4″ nonpareil cork)	1.47

ference in temperature between the two sides of the insulation. These values represent efficiencies under best conditions. In making computations for determining the capacity of refrigerating machines it is customary among some builders to increase these values by from 25 to 50 per cent. according to the physical condition of the insulation.

duct and the neutralizing of the amount of heat generated by lights and workmen entering through the opening of doors.

The 24-hour duty is now found by multiplying 600, the number of square feet of surface, by 5 the heat transmission per square foot, giving 3000 as the number of B.t.u. per 24 hours per degree difference in temperature. This multiplied by 54, the difference between 90 degrees, the assumed maximum outside temperature, and 36 degrees, the required inside temperature, gives 162,000 B.t.u. as the total heat absorbed.

TABLE 2. VALUES OF CONSTANT K, POUNDS REFRIGERATING DUTY PER SQUARE FOOT WALL SURFACE PER 24 HOURS FOR DIFFERENT INSULATION CONDUCTIVITIES AND DIFFERENCES IN TEMPERATURE (t—t'), INSIDE AND OUT. NINETY DEGREES FAHRENHEIT ASSUMED OUTSIDE TEMPERATURE

Inside Temp. (t')	(t–t')	B.T.U. PER SQ.FT. PER DEGREE DIFFERENCE IN TEMPERATURE PER 24 HOURS									
		1	2	3	4	5	6	7	8	9	10
50	40	0.2772	0.5564	0.8346	1.111	1.391	1.669	1.926	2.222	2.5	2.777
48	42	0.2916	0.5832	0.8749	1.166	1.458	1.75	2.041	2.333	2.635	2.916
46	44	0.3055	0.6110	0.9165	1.222	1.527	1.833	2.139	2.444	2.749	3.055
44	46	0.3194	0.6388	0.9582	1.278	1.597	1.916	2.236	2.555	2.875	3.194
42	48	0.3333	0.6667	0.9999	1.333	1.667	2.000	2.333	2 666	3.000	3.333
40	50	0.3492	0.6944	1.042	1.389	1.736	2.083	2.432	2.777	3.125	3.471
38	52	0.3611	0.7222	1 083	1.444	1.805	2 167	2.528	2.889	3.249	3.610
36	54	0.375	0.750	1.125	1.5	1.875	2.25	2.625	3.00	3.375	3 750
34	56	0.3899	0.7778	1.167	1.556	1.945	2.332	2.729	3.119	3.501	3.833
32	58	0.4028	0.8056	1.208	1.611	2.014	2.417	2.82	3.222	3.625	4.028
30	60	0.4166	0.8332	1.25	1.666	2.083	2.5	2.916	3.333	3.749	4 166
28	62	0.4306	0.8612	1.292	1.722	2.153	2.583	3.014	3.485	3.875	4.306
26	64	0.4444	0.8888	1.333	1.778	2.222	2.666	3.001	3.555	4 000	4.444
24	66	0.4583	0.9166	1.375	1.833	2.292	2.75	3.208	3.666	4.125	4.582
22	68	0.4722	0.9444	1.417	1.889	2.361	2.833	3.305	3.778	4.250	4.722
20	70	0.4861	0.9722	1.458	1.944	2.431	2.917	3.403	3.889	4.375	4.861
18	72	5.0	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
16	74	0.5139	1.028	1.542	2 056	2.569	3.083	3.597	4.111	4.625	5.139
14	76	0.5238	1.056	1.583	2.111	2.639	3 167	3.695	4.222	4.750	5.278
12	78	0.5417	1.083	1.625	2.167	2.708	3.25	3.792	4.334	4.875	5.417
10	80	0.5556	1.111	1.667	2.222	2.778	3.333	3.889	4.445	5.000	5.555
8	82	0 5694	1.139	1.708	2 278	2.847	3.416	3.986	4 555	5 125	5.694
6	84	0.5833	1.167	1.75	2 333	2.917	3.5	4.083	4.666	5.250	5.833
4	86	0.5971	1.194	1.792	2.389	2.986	3.583	4.180	4.778	5.375	5.972
2	88	0.6111	1.222	1.833	2.444	3.056	3.667	4.278	4 889	5 500	6.111
0	90	0.625	1.25	1.875	2.5	3.125	3.75	4.375	5.000	5.625	6.250
—2	92	0.6388	1.277	1.916	2.553	3.193	3.835	4.468	5.110	5.750	6.388
—4	94	0.6526	1.301	1.958	2.610	3 262	3.913	4.565	5.22	5.875	6 526
—6	96	0.6666	1.333	2.000	2.666	3.333	4.000	4.666	5.333	6 000	6.666
—8	98	0.6805	1.361	2.165	2.72	3.470	4.82	4.762	5.442	6.125	6.805
—10	100	0.6942	1.388	2.083	2.778	3.192	4.167	4.861	5 555	6.250	6.942

Assuming, for example, a cold-storage box 10x10x10 feet, the superficial surface exposed is 600 square feet.

The insulation is found to consist of two courses of 7/8-inch dressed and matched spruce with a course of paper between, a 1-inch air space and two more courses of spruce with paper between. The conductivity of insulation of this construction is given in the table as 4.25 B.t.u. If the insulation is found to be moist, about 20 per cent. may be added to the above value, which brings the heat transmission up to about 5 B.t.u.

As a matter of fact, 5 B.t.u. per square foot per degree difference in temperature is often employed where the exact value of the insulation cannot be determined, as an approximate factor for estimating the total cold-storage duty required for small- and medium-sized boxes with insulation of the average inferior quality commonly used in market and hotel refrigerators. The amount of refrigerating duty estimated on this basis should be ample to provide not only for the insulation losses but for the cooling of the average small amount of pro-

This divided by 144 B.t.u., the amount of heat required to melt a pound of ice, gives 1125 pounds or 0.5625 ton as the amount of refrigeration required per 24 hours to make up for insulation losses.

A simple expression for pounds of refrigeration K, per 24 hours per square foot of insulation, having a B.t.u. conductivity C, per 24 hours per degree difference in temperature ($t - t_1$), is

$$K = C\frac{(t - t_1)}{144}$$

Substituting in this expression the values in the above example gives

$$K = \frac{5 \times 54}{144} = 1.875$$

which result multiplied by the total square feet of surface, 600, gives 1125 pounds as before.

Table 2 shows similar values of K for different insulation conductivities, ranging from 1 to 10 B.t.u. per square foot and for differences in temperature ranging from 40 to 100 degrees.

To employ this table in the above example, find constant $K = 1.875$ in the horizontal line opposite ($t - t_1$) = 54 degrees and in the vertical column under $C = 5$. This factor multiplied by the surface, 600, gives, as before, 1125 pounds, which divided by 2000 gives 0.5625 ton of refrigeration as the required capacity to make up for insulation losses.

LETTERS

Questions on Refrigeration

I would like to have answers to the following questions concerning an ammonia-compression plant with direct-expansion cooling system:

1. Should the discharge from the ammonia compressor be hot or cold?

2. What are the causes for hot or cold compressor discharge and how remedied?

3. How can one tell whether or not the expansion valve is far enough open?

4. When the suction pressure drops, should the expansion valve be opened more to maintain the pressure?

5. Can the compressor become so cold that the water freezes in the compressor jacket?

6. Will increasing the high or condenser pressure enable me to get better results when the amount of ammonia in the system is below normal?

7. Will some of the evaporating or cooling coils show frost and others not show it when the expansion valve is not opened wide enough, or when there is little ammonia in the system?

8. When some of the coils are covered with frost and some are not and the discharge pipe is either hot or cold, what does this indicate and what is the condition of the gases in the coils?

9. Is there any danger when operating a cooling system with a high suction pressure?

10. To obtain the largest ice output, should there be a large or small difference between the condenser and suction pressures?

Delhi, O. E. J. GALE.

Flooded System

I would like to have the readers of POWER explain thoroughly the workings of the flooded system of refrigeration. Can the capacity of the plant be increased without increasing the coal consumption? Is there any automatic arrangement by which it is possible to maintain an almost constant back pressure?

VICTOR BONN.

New York City.

Turbine Accident at Riverton, Ill.

While bringing the turbine up to speed preparatory to throwing on the line, the third-stage rotor let go, killing two men, seriously injuring two others, and damaging the other machines to such an extent as to put the plant out of service. The turbine was a 2000-kilowatt, 4-stage, vertical Curtis machine.

A peculiar accident occurred at the power house of the Illinois Traction Company at Riverton, Ill., on Thursday evening, July 20. A 2000-kilowatt, 4-stage Curtis turbine was being started and had reached about half speed when the third-stage wheel gave way, breaking half the casing of the steam end into fragments, stripping off the cover on the far side of the machine and sending pieces flying in several directions.

The largest piece, about half of the entire casting, took the direction indicated by the dotted line *A*, Fig. 1, cracking the bedplate of the engine-driven exciter and breaking one of the supports of the high-pressure cylinder of the Corliss engine. The smallest piece took the direction *B*, breaking the exhaust pipe of the smaller turbine, then striking the bedplate of the Corliss engine and making a 9x1½-inch slot in the heavy casting. Also, some smaller fragments damaged the armature windings of this machine. The third piece took the direction *C* and struck the group of men who were starting the turbine; two of these were instantly killed and two others injured, one fatally; a fifth man who happened to be standing near escaped without injury. It then knocked over a 50-kilowatt motor-generator set

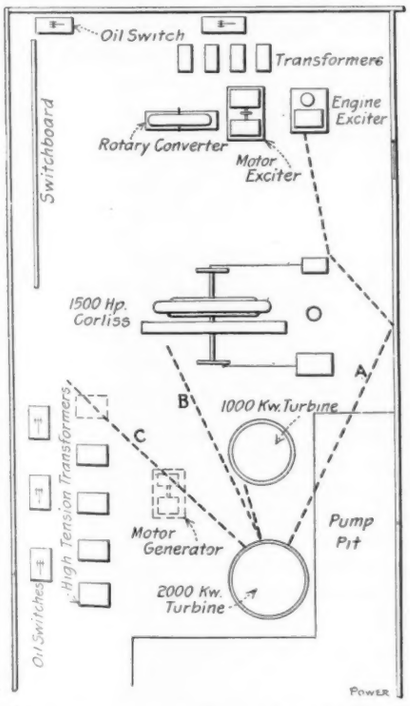


FIG. 1. PLAN OF ENGINE ROOM SHOWING DIRECTION OF FLYING FRAGMENTS

and completely demolished a 100-kilowatt transformer. The railings, piping and connections on the turbines and in the space between the machinery and the boiler room were torn away, and the oil, vacuum and water lines destroyed.

According to information furnished by witnesses, the turbine was running at about 400 revolutions per minute when the rotor failed. The throttle was only partly open, and the boiler pressure was normal at 160 pounds. The step-bearing pressure was 640 pounds, and there was

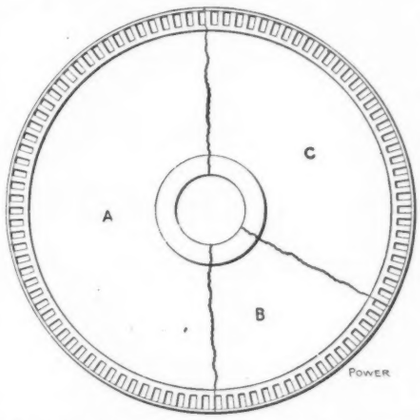


FIG. 2. SHOWING HOW ROTOR RUPTURED

no indication that it had decreased before the failure occurred.

Investigation developed that the turbine had been shut down the previous Monday for a general overhauling and inspection. The steam end had been opened, one section of the intermediate holder had been removed and replaced, the governor had been repaired and a new set of bearings installed; to all appearances everything was in first-class shape. Thursday evening about 6 o'clock the machine was started up cold preparatory to throwing it on the line with the smaller turbine, and had been running at about 400 revolutions per minute for nearly ten minutes when the accident occurred. After the accident it was found that the third-stage wheel had been completely removed from the machine and all that remained of the third-stage diaphragm was a segment of about ⅜ of a circle. The remainder of these parts had been stripped from the steam end as completely as if removed by human hands.

One theory advanced as to the cause of the accident, was that the repairs on the steam end had caused the turbine to be put out of balance and that the vibration resulting at the critical speed produced the failure of the third-stage wheel. The grounds for this theory are not well founded, as the machine had been running for several years in perfect balance, and as far as can be ascertained the character of the work done on the steam end when the turbine was down for repairs was not of such a nature as to put the rotating elements out of balance.

Some engineers who have visited the scene of the accident are inclined to disregard the statement that the turbine was running at half speed, and believe that a defective governor allowed the turbine to run above the normal speed, the noise occasioned by the higher speed being drowned by that of the other turbine eight feet distant, and of the motor-generator near which all of the men were standing.

Another theory and one which seems to be well borne out by the condition of the machine, as observed after the accident, is that a nut, chisel or some other tool, was left in the steam end when repairs were made and this object became wedged between the third-stage wheel and the fourth-stage diaphragm, thus starting the trouble. It was found that although the fourth-stage diaphragm remained in place, it was badly crushed around the inner circumference as indicated in Fig. 3, tending to show

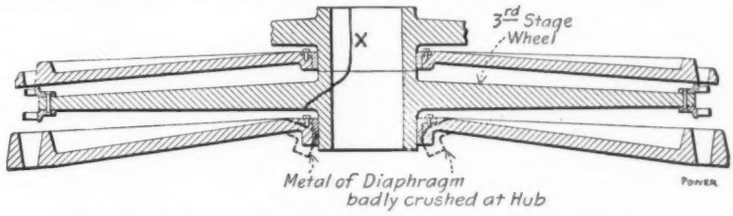


FIG. 3. CRUSHED DIAPHRAGM SHOWN BY DOTTED LINES

that some foreign object had become wedged at this point and started a scoring between the third-stage wheel and the diaphragm until the friction and the

building up of the metal at this point split the third-stage wheel at its hub, causing the fractured wheel to be thrown away from the shaft by centrifugal force, at the same time exerting a tremendous leverage on the cast-iron diaphragm above, splitting this into a number of sections which, falling down upon the rapidly revolving third-stage wheel, were also thrown out by centrifugal force. That the trouble started at the place indicated seems very probable, inasmuch as there are no mutilations on the piece of the third-stage diaphragm remaining in the machine, the only unusual condition being noted on the top of the fourth-stage diaphragm.

Discussion at Boiler Men's Convention

Following are brief abstracts of the committee reports and discussions of the twenty-third annual convention of the American Boiler Manufacturers' Association, held in Boston, July 10 to 13:

After the usual preliminary reports and addresses, the following topical questions were taken up:

1. (a) Will the present type of the butt and strap joint fail frequently in the future as the lap seam has in the past?

(b) Can the butt and strap joint be inspected more thoroughly and with reliance upon conditions found?

(c) Does the expansion and contraction of the excess metal and rivets required to make a butt and strap joint conduce to greater or less efficiency of the joint?

2. What should be the ratio of thickness between a convex and a concave head based on the same radius, tensile strength and working pressure?

3. Are the working pressures of steam, where turbine engines are used, increasing or diminishing?

4. Is it good practice to put turnbuckles in stay rods?

5. In building heavy marine boilers which is the better practice, to put holes in plates before or after bending?

6. (a) Has the passing of laws and the formulation of rules regarding steam boilers reduced the number of explosions or the disastrous results?

(b) If the steam boiler, or any product, is considered dangerous to use or operate but is allowed under regulations of law, should the Government be held responsible in case of disaster?

Taking up question No. 1, President Meier said that there had been several failures last year. Below a certain diameter, say, 36 inches, the value of a double butt-strap joint is very doubtful unless exceedingly heavy metal is employed. In a shell carrying a working pressure of 500 pounds and tested to 900 pounds, it was necessary to use the double butt-strap joint. On such a small shell the width of the joint is a large proportion of the whole circumference, and the shell does not expand like a cylinder. In diameters of 60 to 72 inches this effect is not so apparent. Joints of this description must be made of reliable steel, say, the A. B. M. A. steel, which was specified as early as 1889.

In rolling for a lap joint and in forming the double butt joint, the curve should agree with the curvature of the shell. When a crack is found, drillings should be made around it; any competent chemist can determine the cause of the failure from these drillings. It should also be ascertained whether the curvature of the butt joint conforms to that of the boiler.

It was Mr. McCabe's belief that, while not many flaws are found in the butt-jointed boiler, they are common where the plates are somewhat hard, and the pounding action is bound to occur.

Mr. Ashley believed it necessary to have a signed report from the inspector in order to know that the steel is of good metal within the particular limits of the chemical characteristics, and that the curves conform in general to those of the boiler.

Regarding question No. 2, President Meier said that while tensile strength has its influence on the strength of the head, the compressive strength is much greater. The difference between a theoretical calculation and a practical test must be known. The tensile strength resists the tendency of the material to flatten out. Furthermore, the head is tied to the inside of the shell where the curvature of the shell approaches that of the cylinder. Hence, there is a claw-hammer action which places the rivets in tension as well as in shear.

Regarding the third question, as to whether the working steam pressures, where turbines are used, are increasing or decreasing, President Meier said it appeared that higher pressures were asked for boilers where turbines were employed.

Mr. Hammond thought that no higher pressures were asked for; in marine boilers it was from 210 to 215 pounds.

Mr. Stevens stated that the guarantees as to steam pressures are generally 1 per cent. better for each 10 pounds increased pressure; that is, if the guarantee is based on 200 pounds, 250 pounds would give a 5 per cent. better guarantee. His company did not attempt to convert the old plant where the steam pressure was 150 pounds to the higher pressure; the gain would be so slight that it would not pay to rebuild the plant.

Mr. Hammond, in reference to question No. 4, said that his company sometimes had specifications requiring turnbuckles in stayrods, though this demand did not meet with favor from his people.

As to question No. 5, Mr. Hammond said that his practice is to first drill the outside plates on the edge courses. Where the butt straps come, a few holes smaller than the intended size are drilled to bolt up, followed by the inner course. The heads are next put in, the inside and outside straps are put on and the holes are all in their places. The plates are then taken apart and the burrs removed before the plates are put back for riveting. No punching whatever is done on marine boilers.

Mr. McNeill said that legislation has not only reduced the number of boiler explosions, but it has done much to discontinue the use of boilers which if allowed to operate would result in explosions. Massachusetts has taken a prominent part in bringing about this much-needed remedy. In December, 1910, a disastrous explosion occurred in Massachusetts, caused by increasing the allowable pressure from 70 to 225 pounds, the safety valve having been screwed down by a licensed engineer.

To eliminate such a condition in the future Mr. McNeill stated that it would, in his opinion be necessary to place on each boiler a safety valve, the adjusting screw of which is screwed to a shoulder, thus making it impossible to increase the tension of the spring unless the boiler were put out of commission or the adjusting screw was taken out or replaced by a different one.

Another explosion happened in New Bedford in December, 1910. With these two exceptions, no explosions have occurred in Massachusetts since the passage of the revised inspection laws in 1907.

Detroit and Michigan Rules

At the fourth session the discussion was on the Detroit rules and the proposed Michigan rules as influenced by the Massachusetts standard. President Meier said that the city of Detroit had practically adopted the Massachusetts standard and he believed that the State of Michigan was bound to do likewise. Ohio had practically adopted them.

The absolute necessity for a standard for specifications was cited in the experience of a Boston firm of contracting engineers who received a contract for construction work in Aberta, Northwest Canada. The company took with it machinery which included a Massachusetts standard vertical fire-tube boiler for hoisting material. When the boiler arrived it was found that it could not be operated in Alberta because its construction did not conform to the regulations of the British Board of Trade.

Discussion of Massachusetts Rules

The fifth session was mainly devoted to discussion of uniform boiler inspection laws.

James C. Stewart said that it was difficult to discuss this question without entering into personalities. Public opinion had been doctored regarding the Massachusetts boiler laws; it was not

the opinion of Massachusetts men that its boiler law was a model one; boards of boiler rules and commissions could not rule these men, said the speaker. He believed that the State has throttled the boiler maker and had taken care of other interests. The makers could construct a better boiler than the State; the rules of the board had been spread broadcast and been taken by the throat by the labor unions; the makers have not been treated fairly, said Mr. Stewart. It was his judgment that the makers provided a better boiler for Connecticut, Rhode Island and other States.

Mr. Stewart contended that the makers were classed as malefactors because the State became hysterical over the loss of life in the Brockton explosion, and overlooked the fact that for twenty years previously, less than two lives a year were lost. He said that instead of helping other States to copy its rules, Massachusetts should make its own rules more simple and more practical.

The American Boiler Manufacturers' Association, in securing better material and producing better workmanship has solved the question of boiler safety, rather than the Massachusetts rules; rules and regulations in themselves do not make a good boiler, said Mr. Stewart.

In answer to M. H. Broderick's proposal for the Association to prepare articles for a uniform specification, President Meier said that rules had been formulated by the association as to materials and workmanship as early as 1897 and had since been changed and modified from time to time to suit the requirements.

Mr. Farasey said that with the changes made to meet the contentions of Mr. Stewart, the makers could advise that the specifications be generally adopted.

John A. Stevens stated that the board of boiler rules had sent to every reputable manufacturer copies of its proposed rules, and that from their suggestions were abstracted the best ideas. Furthermore, the Massachusetts inspectors, the insurance companies and all the boiler inspectors were asked to contribute to the formulation; the French, German and British boards of trade rules were also abstracted, and it appeared to the speaker that there was nothing in the rules that could be misunderstood. Mr. Stevens said that the board had corresponded with all the authorities known in the world, and their replies said in plain English: "leave the rules alone."

President Meier said that the 1898 specification was made with the understanding that there would be local details that would have to be settled by local conditions. He would be glad to see the firebar steel supersede the flange steel.

DELEGATES AND VISITORS AT THE MICHIGAN N. A. S. E. CONVENTION

Michigan State Convention of the N. A. S. E.

The tenth annual State convention, which was held at Saginaw on July 20, 21 and 22, was opened by J. D. Swartwout, chairman of the Board of Trade convention committee. A prayer was made by Reverend J. Ambrose Dunkel, pastor of the Warren Avenue Presbyterian church, after which Mayor Stewart, delivered the official address of welcome in which he assured the visitors of the hospitality of the city and invited them to make themselves thoroughly at home. Response to the mayor's welcome was made by State President Brandau. Joseph P. Tracey, secretary of the Board of Trade, also addressed the convention and told of the many advantages offered by the city as a manufacturing and residential place Fred W. Raven was then introduced and spoke regarding the aims and objects of the National Association of Steam Engineers and gave a synopsis of its development since it was organized.

President Brandau, in opening the afternoon session on Thursday, made an interesting address in which he commented upon the satisfactory condition of the organization and outlined some of the work accomplished. He referred in complimentary terms to the additions made to the state organization during the period since the last convention was held, the two cities coming in being Saginaw and Coldwater.

The exhibit at the Auditorium was one of the largest ever held at a Michigan State convention and speaks well for the support given by the various manufacturers of engineering apparatus. In connection with the exhibit the Central States Exhibitors' Association gave a smoker Friday night at the Hotel Vincent at which J. D. Swartwout was the presiding officer. Various speakers were introduced and the songs, stories and bountiful refreshments were thoroughly enjoyed by all. Contributing to the enjoyment of those present the Elks Comedy Four made a big hit, their quartet singing being as good as that heard on the professional stage and their comedy parts being of first-class order.

Officers for the ensuing year were elected as follows: W. E. Fuller, Kalamazoo, president; M. Gormley, Grand Rapids, vice-president; G. A. Turnbull, Flint, secretary; and W. M. Moore, Detroit, treasurer.

To make granulated babbitt metal, melt the babbitt in a ladle, remove the ladle from the fire and allow the metal to cool. When it begins to "set," stir briskly with a stick until it has all cooled into a granular mass. If any particular size of grain is desired, the metal may be sifted, using two screens, one of the desired size mesh to remove the large grains and one slightly smaller to allow the escape of the fine grains.

Annual Convention of the Canadian Association of Stationary Engineers

The twenty-second annual convention of the Canadian Association of Stationary Engineers was held at Stratford, Ontario, on July 25, 26 and 27. The Windsor Hotel was selected as headquarters, and the business of the convention was conducted in the city hall.

The large auditorium on the main floor of the city hall was tastefully decorated for the use of the supplymen in showing their goods and demonstrating their mechanical devices. On the floor above the delegates held their several sessions.

On Monday evening a banquet was held at the assembly hall of the Grand Trunk Railway. Robert Paterson, the congenial toastmaster, introduced the folowing gentlemen who responded to toasts: "The City of Stratford," Mayor Brown; "The C. A. S. E.," J. J. Hegg and W. A. Crockett; "Canada," J. R. MacDonald and H. B. Morphy; "Our Legislature," George Torrent; "Our Manufacturers," George McLagan; "Association No. 31," August Kastella; "Our Exhibitors," John B. Cross; "Our Guests," John A. Robertson and H. Scrimglour; "The Ladies," Albert M. Wickens and W. G. Walters; "The Press," W. S. Dingham. Mr. Ranton, of Rochester, N. Y. spoke briefly of the National Association of Stationary Engineers and hoped that the Canadian Association of Stationary Engineers would rapidly increase. During the evening songs, stories and recitations were rendered by Miss Nellie May, F. G. MacLavish, A. R. Benson, John Brandon and Jack Armour.

On Tuesday morning the convention was formally opened by Mayor Brown, and responses were made for the delegates by President Hegg, Secretary Crockett, Treasurer Wickens and Conductor Robertson.

On Tuesday afternoon a tour of inspection was made through the Grand Trunk Railway shops and power houses.

On Wednesday afternoon, headed by a band of twenty-five pieces, the delegates paraded to Queen's Park, where a most enjoyable outing was held. A ball game between the engineers and supplymen, which was won by the latter, started the festivities.

At eight o'clock on Wednesday evening the delegates and exhibitors were called together in the auditorium to listen to the reading of the following instructive papers: "Cost of Steam Power" by J. O. B. Latour of the Canadian Casualty and Boiler Insurance Company; "Problems in Heating," by C. K. Dean, of the Alberger Condenser Company; and "The Operating Engineers' Ideal and Its Attainments," by Peter Bain, of *The Power House*. Following these discussions the engineers were entertained by the exhibitors at the Windsor Hotel. A theater party for the ladies on Wednesday evening also formed part of the program.

At the final meeting the following executive officers were elected and installed: William Norris, Chatham, president; John A. Robertson, Stratford, vice-president; Wilson A. Crockett, Hamilton, secretary; Albert M. Wickens, Toronto, treasurer; Herman R. Clarke, Hamilton, conductor; Samuel E. Cosford, London, doorkeeper. Belleville was chosen as the place for holding the convention in 1912.

During the convention the following presentations were made: Retiring president, J. J. Hegg, received a gold past-president's jewel, the gift of the delegates; August Kastella, chairman of the local committee, was given a silver mounted umbrella and W. G. Walters, honorary chairman of the Supplymen's Association, was also presented with a valuable umbrella from that body.

The supplymen, at a meeting held on Wednesday afternoon, selected the following officers: Earl F. Hetherington, Goldie and McCulloch Company, president; J. E. Fiddes, James Morrison Brass Manufacturing Company, first vice-president; John B. Goff, Dart Union Company, second vice-president; Gordon C. Keith, *Canadian Manufacturer*, secretary; J. N. Charles, Canadian Fairbanks Company, assistant secretary; H. V. Tyrrell, *The Power House*, treasurer; W. R. Stavert, Jenkins Brothers, superintendent of exhibits; Peter Bain, *The Power House*, chairman of entertainment committee.

Outing of Pawtucket Association of Stationary Engineers

The sixteenth anniversary, reunion and field day of the Pawtucket Association of Stationary Engineers, Rhode Island, No. 2, N. A. S. E. took place on Sunday, July 30. There was the usual big gathering of engineers and their friends. A delegation of upwards of thirty journeyed from New York and Jersey City, and there were also representatives from Boston, Springfield, Lowell and other nearby cities.

The party assembled at the Narragansett hotel, Providence, and special trolley cars were boarded for Palace Gardens on Narragansett bay.

After partaking of a light lunch, outdoor sports were indulged in, the leading feature being a baseball match, in which a team selected from the members of Pawtucket Association No. 2, battled for six innings with the New York delegation, the former winning by the score of 4 to 3. In the afternoon an old-fashioned clambake was served.

In the pavilion, after dinner, there was a vaudeville entertainment which brought to a close a most pleasant occasion.

Chicago's New Smoke Inspector

When the position of chief smoke inspector for Chicago was made vacant by the resignation of P. P. Bird, who accepted a position with the Commonwealth Edison Company, Mayor Harrison determined to place this important position, carrying with it a salary of $4,000 per year, out of the realm of political influence. Therefore, instead of filling the vacancy by direct appointment, he appointed a commission of disinterested and prominent men who were to select a successor to Mr. Bird. After considering the qualifications of several eligible persons, their choice fell to Osborn Monnett, western editor of POWER.

Mr. Monnett has had wide experience in the power-plant field, which should fit him to carry out his new duties with entire satisfaction. A native of Ohio, Mr. Monnett began his engineering career as an oiler on Lake steamers. After spending several years at this, he took out a stationary engineer's license, and held several positions in that line, finally accepting that of chief engineer of the Wheeling & Lake Erie Railway repair shops. His next position was that of chief engineer of the Rock Island repair shops at Moline, Ill., and he later became associated with *The Engineer*. When that paper was merged with POWER, he became a member of the latter's editorial staff, and has held the position of western editor for the past three years.

PERSONAL

Charles C. Moore, of C. C. Moore & Co., the well known firm of San Francisco consulting engineers, has been chosen president of the Panama-Pacific Exposition to be held in San Francisco during 1915. The honor came to Mr. Moore unsolicited, and with an engineer of such wide experience at its head, the coming world's fair promises to be a big success.

Bearings

In a little treatise on "Bearings" is given some forty catechetical questions and answers on antifriction bearings that were distributed some time ago among a few engineers.

It is said by the publisher that the demand for this treatise became so general that he is induced to offer it to all interested in its subject matter.

It is so written that the answers can be easily comprehended by anyone. The two types of antifriction bearings, the ball and roller bearing, are given a clear explanation and their uses, efficiency and adoption are plainly set forth. The treatise may be obtained for 10 cents from J. A. Nelson, 11 John street, N. Y.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

Reeves Automatic Adjustable Valve

In Fig. 1 is shown a sectional view of the adjustable valve which the Trenton Engine Company has been using for some years on its engines. This valve has been changed slightly in that the set-screw extends into the valve head so that by adjusting the sleeve these screws are tightened up and set down into holes drilled into the valve head, thus preventing the sleeve from turning. There are 12 of these holes, allowing an adjustment of ½ of 1/1000 of an inch in the diameter of the valve ring.

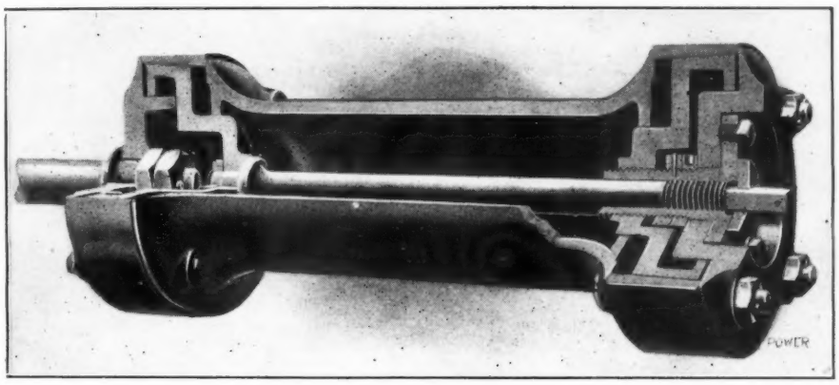


FIG. 1. SECTIONAL VIEW OF ADJUSTABLE PISTON VALVE

This valve has been found satisfactory, except that in some cases the engineer neglected to adjust it at intervals. With these locking devices the valve remains as adjusted.

In Fig. 2, *H* represents a section of this valve which will automatically adjust the rings to make a tight-running valve under all conditions.

The construction is such that the pressure required to hold the valve rings in place is not excessive, because of the wedge-shaped cone and the friction between these surfaces. In other words, the pressure on the piston has simply to resist the tendency to collapse this ring, due to compression and steam in the cylinders after cutoff takes place.

In Fig. 2 *H* represents a section of the cylinder in which the valve seat *B* is shown in section; *D* is the valve rings. These are made eccentric and form a steam-tight joint with the head of the valve at *E*. These rings are grooved as shown and steam leakage past the joint is prevented by a bronze keeper made as shown at *F*. The inside of this keeper forms a section of the ring and the projection rides upon the wide bridge of the port back of the ring *D*.

On the inner side of the ring there is a projection which is faced off at an angle of 60 degrees. This surface faces against the beveled surface of the floating cone which has openings through which the hollow lugs *H H* pass and which project from the valve head *J*.

An auxiliary piston *K* is fitted with a snap ring which slides on the inner surface of the lugs *H H*. When steam is passing through the ports *L L* to the back of the piston *K*, it is forced away from the valve head *J* and carries the floating cone *G* with it. The cone, owing to its beveled outside surface, forces the ring *D* out against the surface of the valve chamber.

This construction of the valve allows the valve ring to take its place against the walls of the valve cage before the compression forces strike the ring and tend to collapse it.

The wear on the valve seat should be very slight, as it is prone to wear it round, the seat of the valve in a horizontal engine being supported by the valve stem and tail rod.

Owing to the peculiar construction, the joint between the valve body and the valve ring on the live-steam side will remain tight, due to the pressure of the cone in this direction.

This improved valve is used on the Reeves single-cylinder and compound engines, but it can be used for other types of engines as well. It is the in-

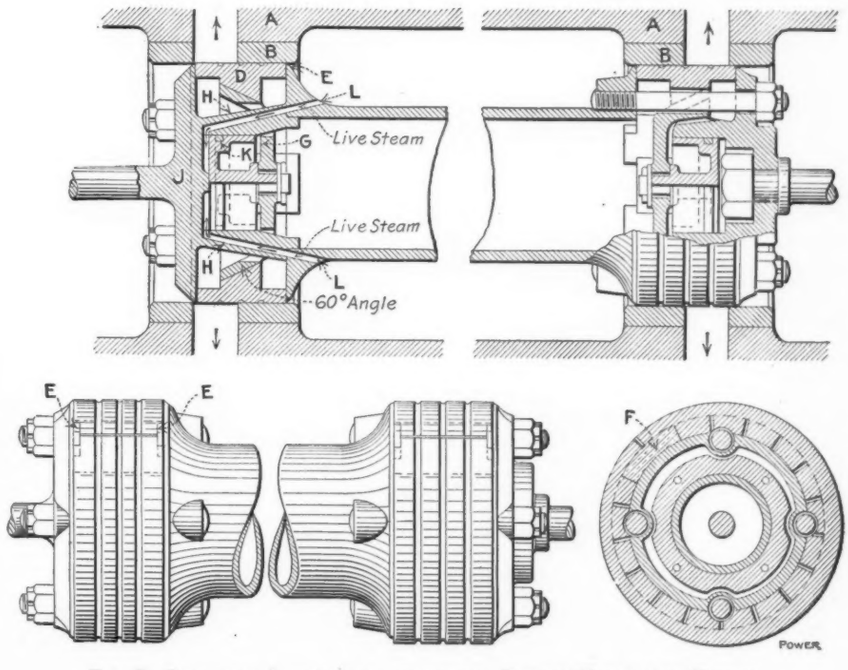


FIG. 2. SHOWING AUTOMATIC ADJUSTING PISTON RINGS AND PISTON

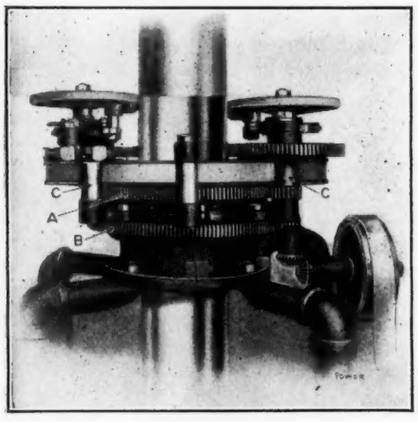
vention of Clifton Reeves, vice-president and general manager of the Trenton Engine Company, Trenton, N. J.

Plunger Rod Grinding Machine

The principal objects of this device are to provide a simple and convenient means for grinding elevator plungers as they reciprocate.

The accompanying illustration shows the device as applied to an elevator plunger. It is so designed that it can be attached to any ordinary stuffing box, on which is mounted a two-part cylinder secured in position as shown. This support is provided at its top with a stationary gear wheel *A*, concentric with the cylinder and plunger. On this support is also fixed a bracket in which is journaled a shaft that receives power from a motor or any other desired source of power.

This shaft is connected by beveled gears to another shaft journaled in the bracket on which is fixed a pinion meshing with the bottom rotable gear *B* of the same size as the stationary gear *A*



PLUNGER-ROD GRINDING MACHINE

and concentric therewith. This gear is mounted on the split support and has a babbitt bearing. Movable with this gear and fixed to it are two brackets *C*, each carrying two grinding wheels on two different carriages. The wheels are at the top of the vertical shafts. On the lower ends of the shafts are two pulleys connected by a belt which is covered with emery and is used for polishing.

The adjustment for setting the grinding wheels against or out from the plunger is done automatically with a wheel arrangement without stopping the machine.

The operation of the device is as follows: The parts having been mounted on the cylinder stuffing box and the driven pulley connected with the motor or other source of power, the rotation of the pulley obviously will cause the gear *B* to rotate, carrying with it the bracket *C C*. This bracket carries a pinion always in mesh with the gear *A* and causes this pinion to turn on its own axis. This rotates the grinding wheels as it travels around the cylinder guides.

The grinding wheels will follow the slight inaccuracies of the plunger to a certain extent, but the object is to grind it smooth rather than to a true cylindrical surface.

It is said that a plunger ground in this way will operate efficiently and not cut the packing in the stuffing box.

This device is the invention of A. P. Klingloff, 28 Kittredge street, Roslindale, Mass.

Uehling Draft Recording Gage

The Uehling draft recorder was designed to record accurately differences in vacuum below 0.10 of an inch of water.

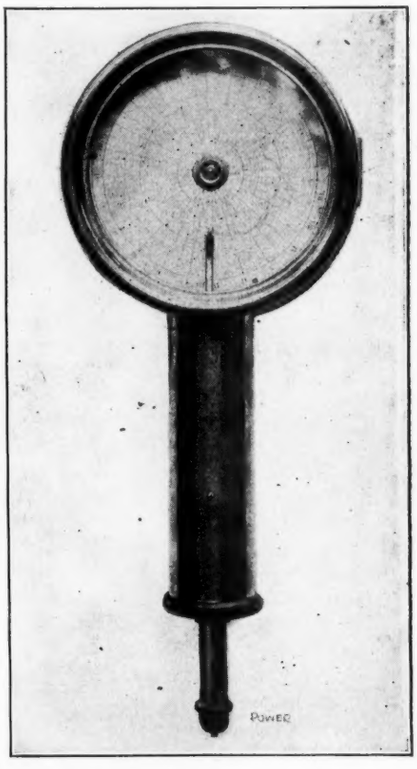


FIG. 1. UEHLING DRAFT-RECORDING GAGE

Fig. 1 shows a front and Fig. 2 a sectional view of this gage.

It consists of a case containing a clockwork *T*, Fig. 2, which drives a disk *E* upon which is mounted a circular sheet of recording paper. Directly under this case is mounted a cylindrical vessel *A* containing oil. Concentric with this vessel is placed a tube *K* containing mercury *M*, as shown. The bell *B* which is sealed by the oil *O* is buoyed up by the float *F* on the stem *S* which is immersed in the mercury. The pen *P* is supported and moved directly by the bell by means of the elastic arm *R*. A pipe *G* communicates with the sealed chamber formed by the bell.

If suction or draft is applied to *G* the bell descends until it is balanced by the mercury displaced during the descending of the stem *S*, the diameter of which is so proportioned as to give the desired range.

A record on a chart of 2-inch range can be read to 0.025 inch, while records made on a chart of 1-inch range can be read accurately to 0.01 inch of water

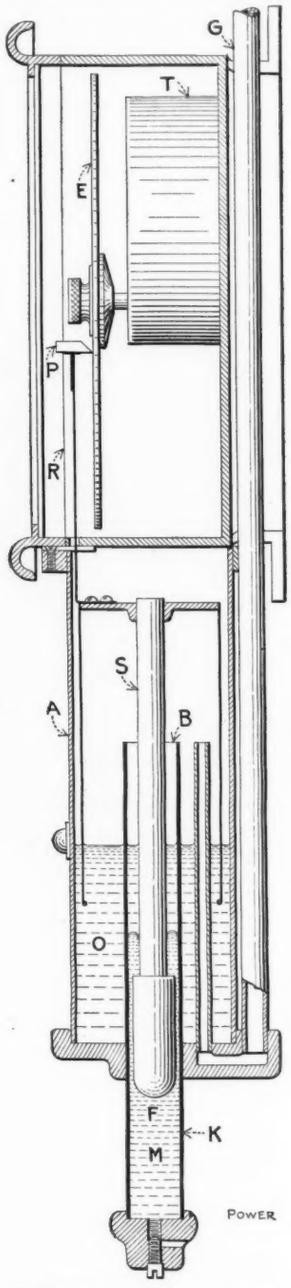


FIG. 2. SECTIONAL VIEW OF THE GAGE

column. The charts are standard, but the recorder is applicable to recording very light pressures as well as draft.

This draft recorder has no spring or multiplying lever to get out of adjustment or calibration, and it is simple in construction, accurate and reliable. It is made by the Uehling Instrument Company, Passaic, N. J.

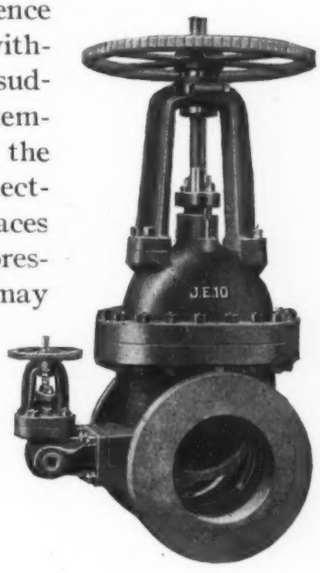
TRADE JENKINS MARK

Jenkins Bros.

Jenkins Bros. Valves For High Pressure Superheated Steam

For high pressure superheated steam our Extra Heavy Pattern Globe, Angle, Cross or Check and Extra Heavy Gate Valves are made with bodies and bonnets of cast steel, having a tensile strength of 68,000 to 70,000 lbs.

The seat rings, discs and spindles are made of Monel Metal. This is a natural alloy containing about 70% nickel. In addition to being very hard, durable and non-corrosive it has the same coefficient of expansion as the cast steel, thus providing a combination which experience has proved to be best adapted to withstand the destructive effects of the sudden and frequent wide variations in temperature which usually accompany the use of superheated steam. All connecting flanges are made with raised faces inside bolt holes and approved high pressure gaskets or ground joints as may be specified. Bolt holes are counterfaced for nuts. They are suitable for working steam pressures up to 350 pounds and total temperature of 800° F.



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But if he can't supply you write us for name of nearest dealer who can. Also write us for our latest catalog.

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Pumps, Electric
American Well Works..... 99
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Westinghouse Elec. & Mfg. Co.118

Pumps, Oil
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Pumps, Oil Force-feed
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Richardson-Phenix Co. 78

Pumps, Pneumatic
Ingersoll-Rand Co. 93

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Ingersoll-Rand Co..... 93
Jamieson & Co., M. W..... 96
Minneapolis Steel & Mchy. Co.110
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Union Steam Pump Co..... 96
Wheeler Cond. & Engr. Co.... 98
Wheeler Mfg. Co., C. H..... 96
Worthington, Henry R..... 96

Pumps, Vacuum
Alberger Pump Co..... 98
American Well Works..... 99
Cameron Steam Pump Wks., A. S..... 98
Connersville Blower Co., The. 98
Goulds Mfg. Co..... 98
Union Steam Pump Co..... 96
Wheeler Cond. & Engr. Co.... 98
Wheeler Mfg. Co., C. H..... 96

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Penberthy Injector Co..... 13

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Robertson & Sons, Jas. L.... 75
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Liberty Mfg. Co..... 7
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Hughson Steam Specialty Co. 82
Mason Regulator Co..... 83
"S-C" Regulator Co..... 92
Squires Co., C. E..... 90
Ziermore Regulator Co.....105

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American Steam Gauge and Valve Mfg. Co.....62 and 63
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Rheostats
General Electric Co.....117

Rope, Transmission
American Mfg. Co..... 93
Columbian Rope Co..... 93

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Diamond Rubber Co..... 74
Quaker City Rubber Works... 72

Second Hand Machinery
Stewart Co,, The Paul..... 71

Separators, Ammonia
Elliott Co. 7
Harrison Safety Boiler Wks.. 65

Separators, Oil
Austin Separator Co..... 92
Baragwanath & Son, Wm.....100
Elliott Co. 7
Harrison Safety Boiler Wks.. 65
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Liberty Mfg. Co..... 7
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Austin Separator Co..... 92
Baragwanath & Son, Wm....100
Elliott Co. 7
Griscom-Spencer Co.....101
Harrison Safety Boiler Wks.. 65
Hoppes Mfg. Co.....104
Liberty Mfg. Co..... 7
Nashua Machine Co..... 90
Ohio Blower Co..... 87
Patterson & Co.. Frank L....100
Robertson & Sons, Jas. L.... 75
Whitlock Coil Pipe Co.....100
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Green Engineering Co..... 88

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American Ship Windlass Co.. 88
Babcock & Wilcox Co.....103
Green Engineering Co..... 88
Lagonda Mfg. Co.....3d cover
McClave-Brooks Co..... 14
Murphy Iron Works..... 88
Parson Mfg. Co..... 88
Under-Feed Stoker Company of America..... 89

Strainers, Pump Suction
American Ship Windlass Co.. 88
Elliott Co. 7
Lagonda Mfg. Co.....3d cover

Strainers, Water
Liberty Mfg. Co..... 7

Superheaters
Babcock & Wilcox Co.....103
Nelson Valve Co..... 81
Power Specialty Co..... 74
Providence Engineering Wks.113

Switchboards
General Electric Co.....117

Switches, Electric
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Westinghouse Elec. & Mfg. Co.118

Tachometers
Schuchardt & Schutte..... 92

Tanks
Griscom-Spencer Co.....101

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Toledo Pipe Threading Machine Co..... 86

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Underwood & Co., H. B.....113

Transformers and Converters
General Electric Co.....117
Jeffrey Mfg. Co..... 93
Westinghouse Elec. & Mfg. Co.118

Traps, Steam
American District Steam Co..105
Anderson Co., V. D..... 90
Chaplin-Fulton Mfg. Co.....106
Elliott Co. 7
Griscom-Spencer Co. 101

Traps, Steam—*Continued.*
Jenkins Bros..... 67
Lytton Mfg. Corporation..... 91
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Lytton Mfg. Corporation..... 91
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Tube Cleaners
Bayer Steam Soot Blower Co.106
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Garlock Packing Co..... 9
Johns-Manville Co., H. W.... 73
Lagonda Mfg. Co.....3d cover
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Robertson & Sons, Jas. L.... 75
Simonds & Co., G. L.....103
St. John, G. C..... 92
Vulcan Soot Cleaner Co.....103

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Lagonda Mfg. Co.....3d cover
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Tubing
Johns-Manville Co., H. W.... 73
National Tube Co..... 86

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Allis-Chalmers Co.....109

Turbines, Steam
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Hooven, Owens, Rentschler Co.113
Sturtevant Co., B. F.....110
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Unions
Dart Mfg. Co., E. M..... 86
Jefferson Union Co..... 10
Lunkenheimer Co..... 4
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Valve Balls
Diamond Rubber Co..... 74

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Diamond Rubber Co..... 74

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Schieren Co., Chas. A..... 93

Valves, Ammonia
Chapman Valve Mfg. Co..... 83
Monarch Valve & Mfg. Co.... 82

Valves, Angle
Homestead Valve Mfg. Co.... 83
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co.... 82
National Tube Co..... 86
Nelson Valve Co..... 81
New Bedford Valve Mfg. Co.. 82

Valves, Automatic Cut-Off
Alberger Heater Co.....100
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Hughson Steam Specialty Co. 82
Jenkins Bros..... 67
Perkins Co., Jno. B..... 83

Valves, Blow-off
Ashton Valve Co., The..... 84
Elliott Co. 7
Homestead Valve Mfg. Co.... 83
Jenkins Bros..... 67
Liberty Mfg. Co..... 7
Lunkenheimer Co..... 4
Yarnall-Waring Co..... 86
Ziermore Regulator Co.....105

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Mason Regulator Co..... 83
Nelson Valve Co..... 81

Valves, Check
Greene, Tweed & Co., 79 and 4th cover
Jenkins Bros..... 67
Lunkenheimer Co..... 4
National Tube Co..... 86
Nelson Valve Co..... 81

Valves, Cylinder Relief
American Steam Gauge and Valve Mfg. Co.....62 and 63
Ashton Valve Co., The..... 84
Lunkenheimer Co..... 4
Perkins Co., Jno. B..... 83

Valves, Exhaust Relief
Alberger Pump Co..... 98
Jenkins Bros..... 67

Valves, Float
Schade Valve Mfg. Co..... 84

Valves, Free Exhaust
Schutte & Koerting Co..... 82

Valves, Gate
Chapman Valve Mfg. Co..... 83
Detroit Lubricator Co..... 79
Greene, Tweed & Co., 79 and 4th cover
Jenkins Bros..... 67
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co.... 82
National Tube Co..... 86
Nelson Valve Co..... 81
Pittsburgh Valve, Fdry. & Construction Co..... 83

Valves, Globe
Detroit Lubricator Co..... 79
Jenkins Bros..... 67
Lunkenheimer Co..... 4
National Tube Co..... 86
Nelson Valve Co..... 81
New Bedford Valve Mfg. Co.. 82
Pittsburgh Valve, Fdry. and Construction Co..... 83

Valves, Piston
Baker Valve Co.....110

Valves, Pump
Garlock Packing Co..... 9
Jenkins Bros..... 67
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co..... 8
Quaker City Rubber Works... 72
Schade Valve Mfg. Co..... 84

Valves, Reducing
Mason Regulator Co..... 83
Ziermore Regulator Co.....105

Valves, Regrinding
Lunkenheimer Co..... 4
National Tube Co..... 86
Nelson Valve Co..... 81

Valves, Regulating
Engineers Appliance Co., The. 83
Hughson Steam Specialty Co. 82
Lunkenheimer Co..... 4
Mason Regulator Co..... 83
Nelson Valve Co..... 81
Schade Valve Mfg. Co..... 84
Ziermore Regulator Co.....105

Valves, Return Stop
Lagonda Mfg. Co.....3d cover

Valves, Safety
American Steam Gauge and Valve Mfg. Co.....62 and 63
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Crosby Steam Gage & Valve Co. 85
Detroit Lubricator Co..... 79
Jenkins Bros..... 67
Lunkenheimer Co..... 4
National Tube Co..... 86

Valves, Stop Check
Jenkins Bros..... 67
Lagonda Mfg. Co.. ....3d cover
Perkins Co., Jno. B..... 83
Schutte & Koerting Co..... 82

Valves, Superheated Steam
Chapman Valve Mfg. Co..... 83
Lunkenheimer Co..... 4
Nelson Valve Co..... 81

Valves, Tank
Nelson Valve Co..... 81

Valves, Throttle
Detroit Lubricator Co..... 79

Valves, Trip Throttle
Schutte & Koerting Co..... 82

Ventilators
Burt Mfg. Co..... 18
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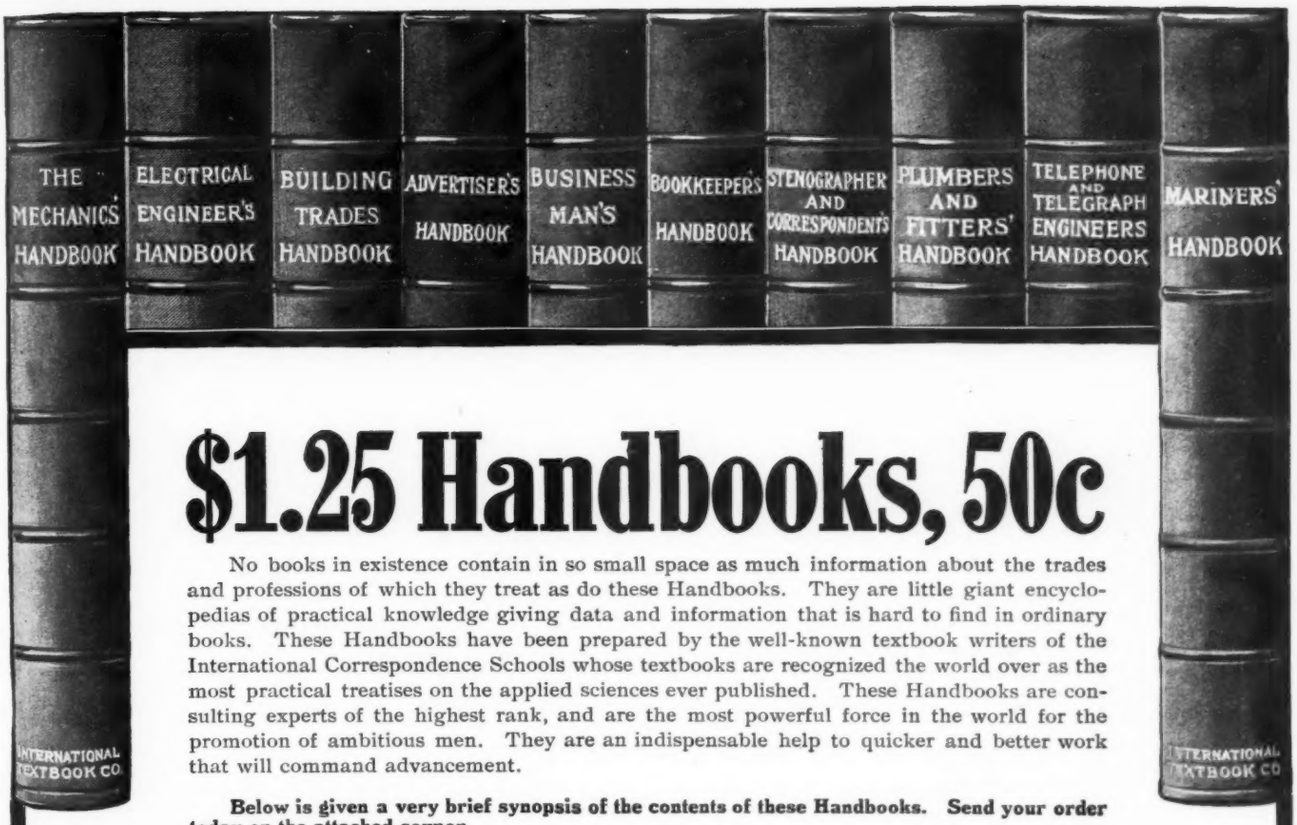

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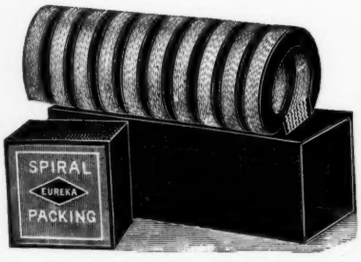

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